Smithsonian

ULY 2001

New York's New Planetarium Revives the Art of Glass

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features

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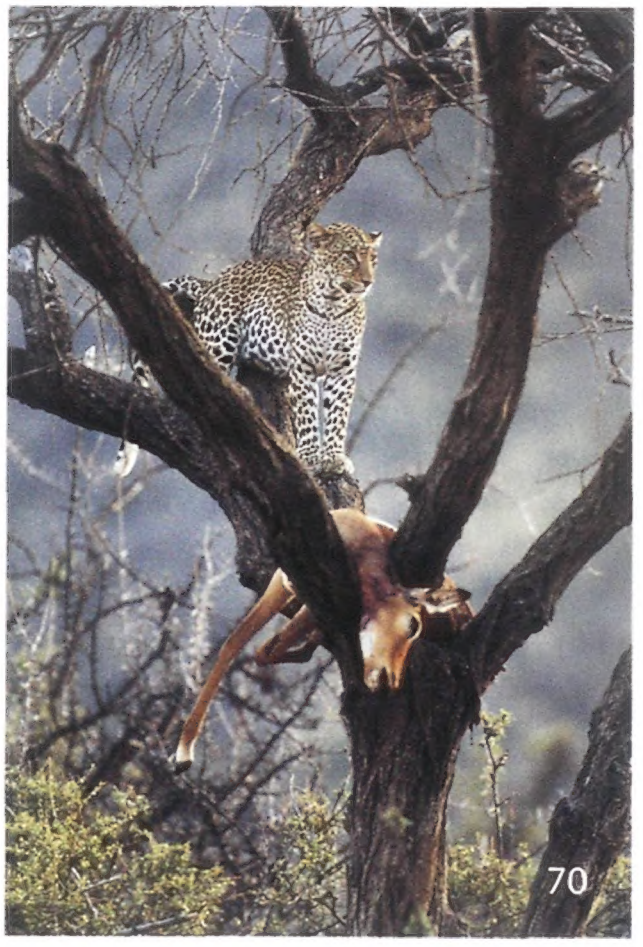

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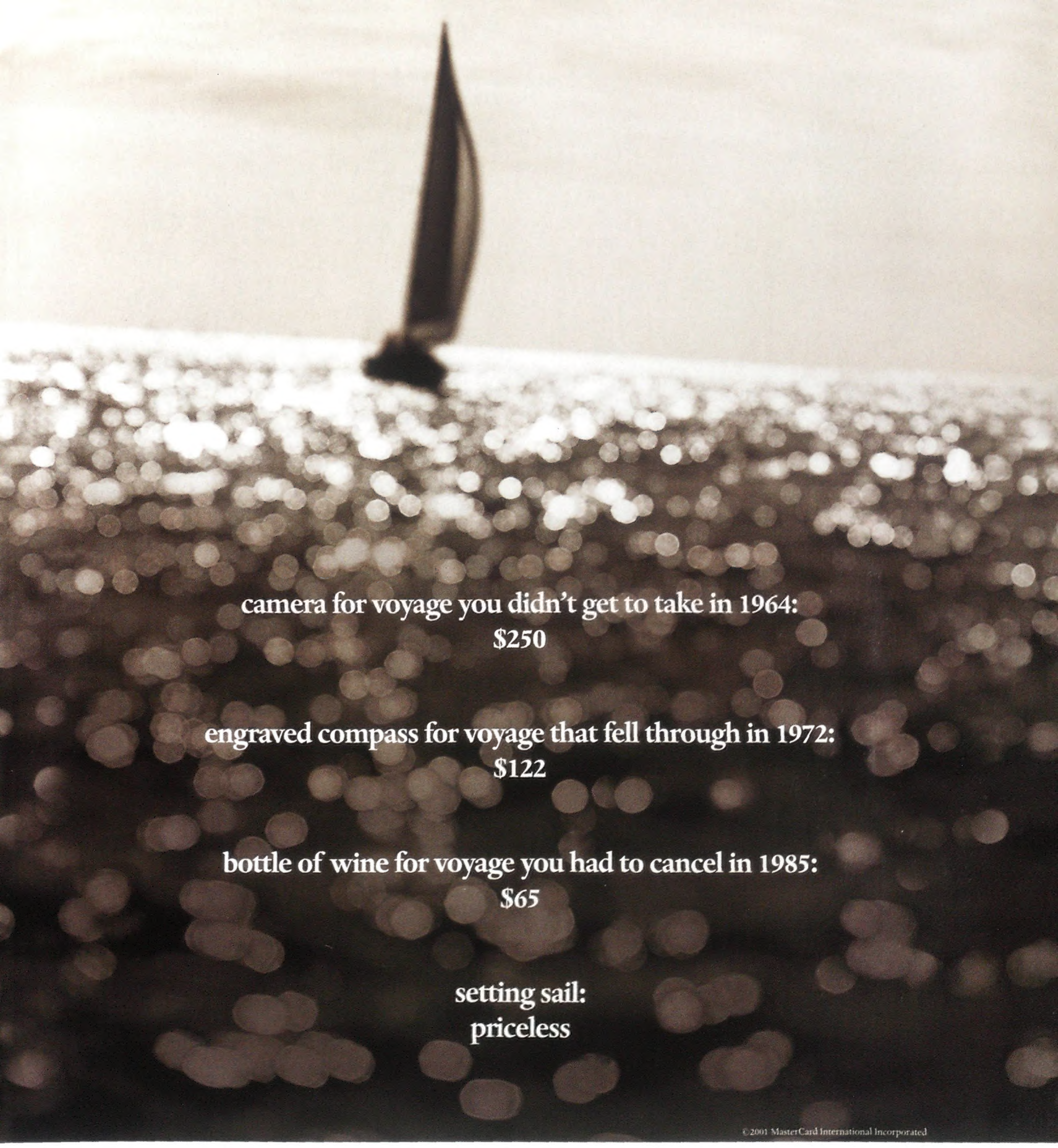
Detailing fires, plague and the goings-on at court, his diaries provide a fascinating glimpse into life in Restoration England

BY CHARLES ELLIOTT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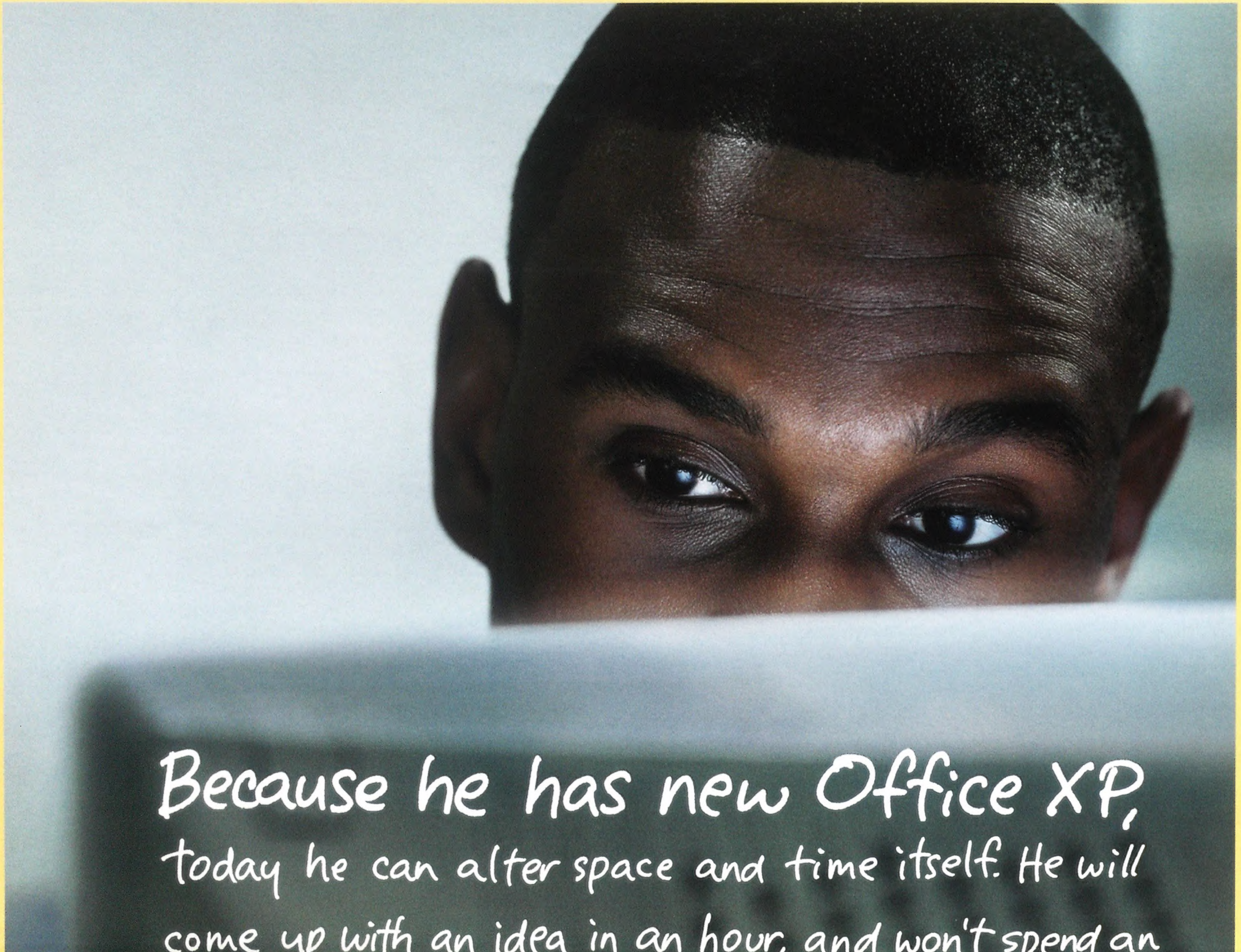
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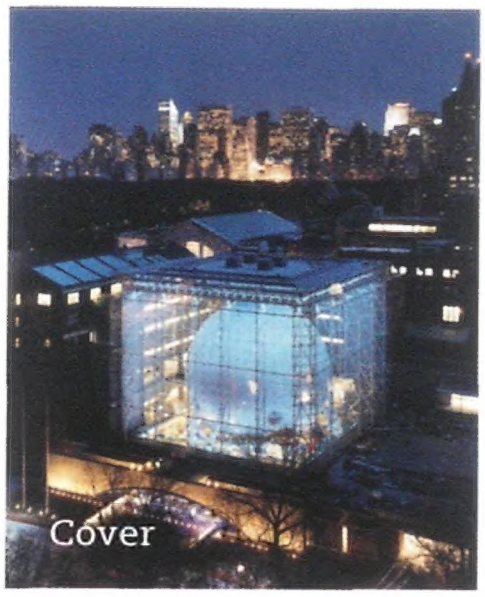

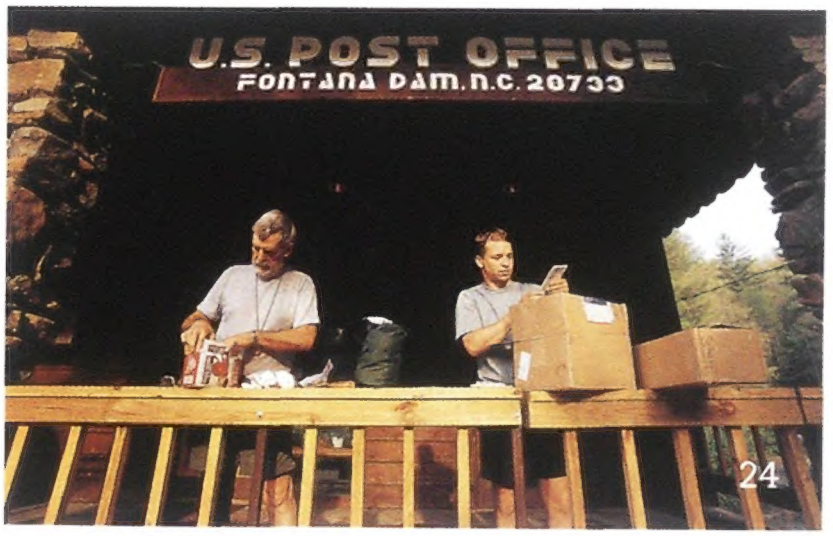

Cover Adjacent to New York's American Museum of Natural History, the Rose Center for Earth and Space boasts the largest suspended glass curtain wall in the United States. Almost an acre of glass was used to construct the 95-foot-high cube. Inside rests the Hayden Sphere, its upper portion housing a state-of-the-art planetarium.
PHOTOGRAPH BY JEFF GOLDBERG/ESTO

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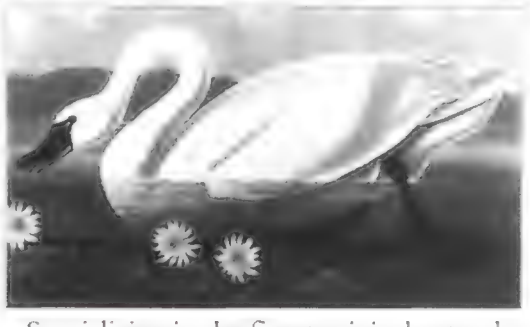

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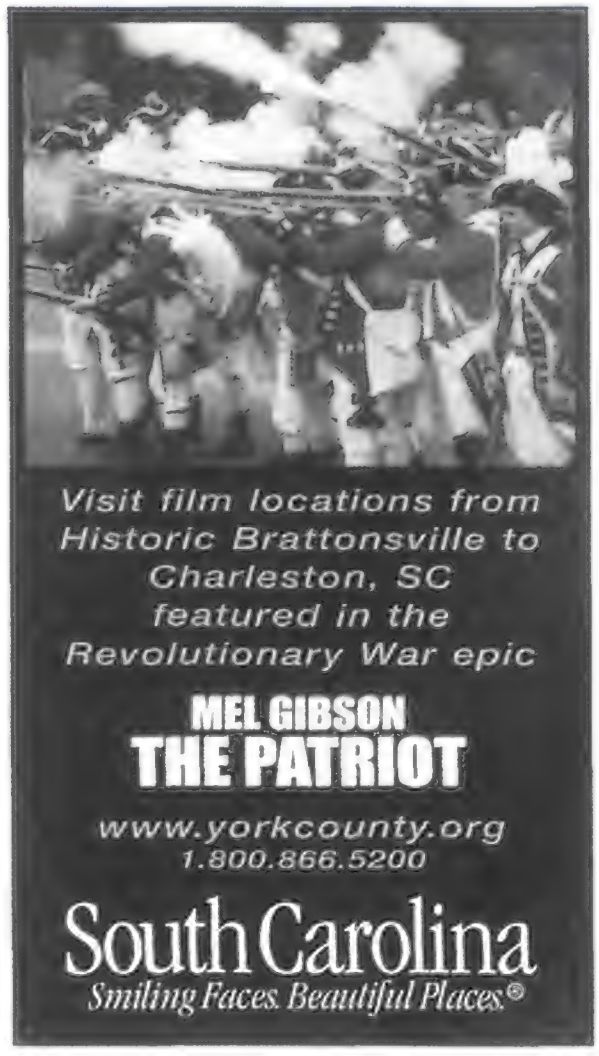

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A NOTE FROM THE SECRETARY

DONATIONS TO THE SMITHSONIAN INSTITUTION BY benefactors who want to be involved in how their gifts are used have recently been in the headlines. But they would hardly have been news to James Smithson, the English scientist who bequeathed his estate to found the Institution that now bears his name. That the Smithsonian was named for its first donor is no coincidence. While it was a fitting display of gratitude for Smithson's generosity, it was also a condition of his gift.

That historical fact provides a dose of perspective amid a certain amount of controversy over recent gifts to the Smithsonian: private donors have always played an integral part in the Smithsonian's life—and part of that role has always been some degree of participation in the use of their gifts. Charles Freer placed limits on the acquisition and use of works of art in what became the Freer Gallery. Dr. Arthur M. Sackler and Joseph Hirshhorn were also involved in the formation of the world-class facilities on the National Mall that are named for them.

Similarly, Kenneth E. Behring and Catherine B. Reynolds—both of whom recently made sizable donations to the National Museum of American History—are following in the long-standing tradition that James Smithson began. Mr. Behring has pledged $80 million to the museum for a major renovation of its exhibitions. Ms. Reynolds has promised $38 million to build an exhibition that would highlight the personal histories and achievements of individual Americans who have excelled in science, the arts, public service and other areas of endeavor—Nobel Prize winners, Medal of Honor recipients, Presidential Medal of Freedom awardees and members of the Academy of Arts and Sciences, for example.

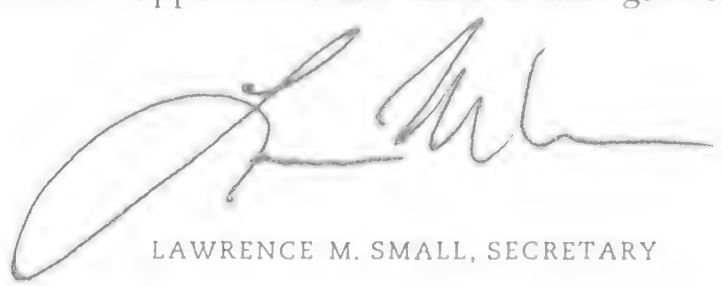
Some at the National Museum of American History are concerned that conditions attached to the donations—such as the nature of Mr. Behring's involvement in the revitalization of the museum and Ms. Reynolds' participation in the process of deciding whom to honor in the exhibition on achievement—will somehow compromise the Smithsonian's independence.

Those concerns deserve a forthright response. As I have emphatically stated, no financial contribution is worth the sacrifice of the public's trust in the Smithsonian. And these donations do not in any way compromise our standards. While the Institution has continued its century-and-a-half-long tradition of allowing donors a say in the use of their gifts, it has ceded no control over either the content of exhibitions or final decision-making about the museum's governance.

Many of the criticisms leveled against recent donations are based on erroneous information. For example, critics charge that the terms of Ms. Reynolds' donation give her the power to appoint an advisory board for the exhibition. In fact, though, she has the power only to nominate candidates. No one may become a member of the advisory board without approval from the Smithsonian's Board of Regents, and the contract documenting the gift explicitly says the Institution's staff will retain final control in the case of any dispute over the content of the exhibition.

A plan to renovate the National Museum of American History was envisioned well before Mr. Behring made his gift. His generosity now makes it possible to carry out this much-needed transformation. While some have questioned whether Mr. Behring has authority over the museum's renewal program, he does not. His input is obviously highly important to us, but the final authority lies with the Smithsonian.

The Smithsonian is the largest museum and research complex in the world, the guardian of America's greatest cultural, scientific and historic treasures. The resources provided through private partnerships and the support of Congress enable the Institution to better serve the public, to spark the imagination and inspire the love of learning—for students of all ages. We tell the story of our nation's democracy, and how each generation discovers—and rediscovers—what it means to be an American. Because we share the same goal, throughout our history, many patriotic citizens have offered to help in the effort. We welcome their support and thank them for their generosity.



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AROUND THE MALL AND BEYOND

THANK YOU FOR MICHAEL KERNAN'S column "Executive Images," in the May 2001 issue. I thought your readers might be interested in a little-known point about the "S" in Harry Truman's name. In the 1960s, I was a proofreader for the *Savannah Morning News*, and the former President's name frequently came up in copy. To put to bed the issue of whether or not the "S" should have a period after it, I wrote to Mr. Truman. On January 5, 1968, he replied:

"With reference to your recent letter, regarding the 'S' in my name, it can be used either with or without the period after it.

"I was named for my grandfathers and in order to be strictly impartial in naming me for one or the other, I was given the letter 'S' as a middle name."

His personal letterhead read "Harry S Truman"—no period.

Jack Lightfoot
Tiger, Georgia

ALEXANDER CALDER

NOT EVERYONE WAS ENTHRALLED with Alexander Calder's self-staged *Circus* performance, which Phyllis Tuchman described in "Calder's Playful Genius." Biographers of novelist Thomas Wolfe describe a January 3, 1930, party at the swank Park Avenue apartment of Aline Bernstein (Wolfe's mistress) and her husband, Theodore, at which both Wolfe and Calder were guests. Calder rearranged the Bernstein's furniture and strewed the floors with sawdust. The artist spent hours setting up the tiny wire figures, by which time bored guests began drifting away. Wolfe later wrote a satirical account of Calder's performance art in "Piggy Logan's Circus," a chapter in the posthumously published novel *You Can't Go Home Again*.

Donald Howard
Poway, California

GHOST TOWNS

BERTHOLD STEINHILBER'S HAUNTING depictions in "Ghost Towns by Night Light" are an enchanting record of bonanzas abandoned and dreams gone bust. They go beyond photography into the realm of art.

Ashby W. Campbell
Tucson, Arizona

I REMEMBER WELL THE GHOST TOWN of Bodie, California, from my days after college when I fell in with a couple of other men who were hunting for "Peruvian moss"—a desert shrub for tabletop decorations. We heard that a "good" girl, if destined to move to Bodie, said, "Good-bye God, I'm going to Bodie." A "bad" girl said, "Good, by God, I'm going to Bodie!"

John J. Hall
Richmond, California

SOMETHING ABOUT THE FACADE OF the Stark Brothers Mercantile store and the Home Comfort Hotel in St. Elmo, Colorado, caught my eye. Several of the windows in the long-abandoned buildings exhibit what look like bouquets of red flowers. Does some spirit wander the lonely rooms at dusk, faithfully placing emblems to a lost love?

Jimmy J. Cone
Austin, Texas

Ghost towns are not necessarily abandoned, and St. Elmo is one of these. The last original, full-time residents were siblings Annabelle and Tony Stark, who left in 1958. St. Elmo has about 70 properties, and a few people reside in town year-round. A volunteer group known as the St. Elmo Ghosts maintains the old mining town in its state of arrested decay, so yes, it was a ghost who arranged the flowers. Ed.

WAS I SURPRISED TO SEE THE PICTURE of the old Alley Belle Mine in St. Elmo, Colorado. My boyhood friend Dean Dale and I used to walk by it on our way to fish the Grizzly and Pomeroy lakes. And the first time I was in the Stark Brothers store and the post office was 1932 or 1934. Grandma Stark was alive then and was always dressed in black with a black shawl around her head. Back then there was a well pump just outside your picture's frame, to the left. Every day Grandma Stark pumped what water she needed. An old man who lived in the cabin in the back of the store claimed he grew up in St. Elmo and had a sign on his front gate: "Charlie—The King of Chaulk Creek." What memories.

Lyman W. Bader
Littleton, Colorado

THE OBJECT AT HAND

I READ CAROLYN HUGHES CROWLEY'S "Aid in Small Boxes" with warm remembrance. In 1961, when I was 13 years old, I responded to a CARE advertisement and sent in a 50-cent donation, a large amount at the time for me, but in reality, quite small. Some time later I received a gracious letter of thanks, written in German, from Agneta and Werner Frank of Berlin. Translated, it said in part: "For the CARE package we have great joy and we offer our heartfelt thanks for it. We are joyful over the food." I learned that the Franks had two children, a 9-year-old girl in the third grade and a 4-year-old boy "who has yet two years' time to wait for school."

Thank you for highlighting the wonderful work that CARE has done for more than 50 years.

Spencer Brand
Annandale, Virginia

THE LAST PAGE

IN HIS "BEDTIME HORRORS," LARRY Wallberg wrote about his parents' 1957 decorating project that still gives him the willies. I can empathize. Par-

Allergy Season?

Allegra Season!

Seasonal allergies can make you feel miserable. Only once-daily Allegra 60 mg delivers more fexofenadine for long lasting, non-drowsy allergy relief so you can feel more like yourself again. For people 12 and older. Side effects with Allegra 180mg are low and may include headache, upper respiratory tract infection and back pain. Please see additional important information on the next page. 1-800-ALLEGRA www.allegra.com Call your doctor or pharmacist now for more information.

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Brief Summary of Prescribing Information as of November 2000

ALLEGRA®

(fexofenadine hydrochloride)

Capsules and Tablets

INDICATIONS AND USAGE

Seasonal Allergic Rhinitis

ALLEGRA is indicated for the relief of symptoms associated with seasonal allergic rhinitis in adults and children 6 years of age and older. Symptoms treated effectively were sneezing, rhinorrhea, itchy nose/palate/throat, itchy/watery red eyes.

Chronic Idiopathic Urticaria

ALLEGRA is indicated for treatment of uncomplicated skin manifestations of chronic idiopathic urticaria in adults and children 6 years of age and older. It significantly reduces pruritus and the number of wheals.

CONTRAINDICATIONS

ALLEGRA is contraindicated in patients with known hypersensitivity to any of its ingredients.

PRECAUTIONS

Drug Interaction with Erythromycin and Ketoconazole

Fexofenadine hydrochloride has been shown to exhibit minimal (ca. 5%) metabolism. However, co-administration of fexofenadine hydrochloride with ketoconazole and erythromycin led to increased plasma levels of fexofenadine hydrochloride. Fexofenadine hydrochloride had no effect on the pharmacokinetics of erythromycin and ketoconazole. In two separate studies, fexofenadine hydrochloride 120 mg twice daily (two times the recommended twice daily dose) was co-administered with erythromycin 500 mg every 8 hours or ketoconazole 400 mg once daily under steady-state conditions to normal, healthy volunteers (n=24, each study). No differences in adverse events or QT_c interval were observed when patients were administered fexofenadine hydrochloride alone or in combination with erythromycin or ketoconazole. The findings of these studies are summarized in the following table:

Effects on steady-state fexofenadine hydrochloride pharmacokinetics after 7 days of co-administration with fexofenadine hydrochloride 120 mg every 12 hours (two times the recommended twice daily dose) in normal volunteers (n=24)

Concomitant Drug	$C_{max,SS}$ *(Peak plasma concentration)*	$AUC_{SS,0-12h}$ *(Extent of systemic exposure)*
Erythromycin (500 mg every 8 hrs)	+82%	+109%
Ketoconazole (400 mg once daily)	+135%	+164%

The changes in plasma levels were within the range of plasma levels achieved in adequate and well-controlled clinical trials.

The mechanism of these interactions has been evaluated in *in vitro*, *in situ*, and *in vivo* animal models. These studies indicate that ketoconazole or erythromycin co-administration enhances fexofenadine gastrointestinal absorption. *In vivo* animal studies also suggest that in addition to increasing absorption, ketoconazole decreases fexofenadine hydrochloride gastrointestinal secretion, while erythromycin may also decrease biliary excretion.

Drug Interactions with Antacids

Administration of 120 mg of fexofenadine hydrochloride (2 x 60 mg capsule) within 15 minutes of an aluminum and magnesium containing antacid (Maalox®) decreased fexofenadine AUC by 41% and C_{max} by 43%. ALLEGRA should not be taken closely in time with aluminum and magnesium containing antacids.

Carcinogenesis, Mutagenesis, Impairment of Fertility

The carcinogenic potential and reproductive toxicity of fexofenadine hydrochloride were assessed using terfenadine studies with adequate fexofenadine hydrochloride exposure (based on plasma area-under-the-concentration vs. time [AUC] values). No evidence of carcinogenicity was observed in an 18-month study in mice and in a 24-month study in rats at oral doses up to 150 mg/kg of terfenadine (which led to fexofenadine exposures that were respectively approximately 3 and 5 times the exposure from the maximum recommended daily oral dose of fexofenadine hydrochloride in adults and children).

In *in vitro* (Bacterial Reverse Mutation, CHO/HGPRT Forward Mutation, and Rat Lymphocyte Chromosomal Aberration assays) and *in vivo* (Mouse Bone Marrow Micronucleus assay) tests, fexofenadine hydrochloride revealed no evidence of mutagenicity.

In rat fertility studies, dose-related reductions in implants and increases in postimplantation losses were observed at an oral dose of 150 mg/kg of terfenadine (which led to fexofenadine hydrochloride exposures that were approximately 3 times the exposure of the maximum recommended daily oral dose of fexofenadine hydrochloride in adults).

Pregnancy

Teratogenic Effects: Category C. There was no evidence of teratogenicity in rats or rabbits at oral doses of terfenadine up to 300 mg/kg (which led to fexofenadine exposures that were approximately 4 and 31 times, respectively, the exposure from the maximum recommended daily oral dose of fexofenadine in adults). There are no adequate and well controlled studies in pregnant women. Fexofenadine should be used during pregnancy only if the potential benefit justifies the potential risk to the fetus.

Nonteratogenic Effects. Dose-related decreases in pup weight gain and survival were observed in rats exposed to an oral dose of 150 mg/kg of terfenadine (approximately 3 times the maximum recommended daily oral dose of fexofenadine hydrochloride in adults based on comparison of fexofenadine hydrochloride AUCs).

Nursing Mothers

There are no adequate and well-controlled studies in women during lactation. Because many drugs are excreted in human milk, caution should be exercised when fexofenadine hydrochloride is administered to a nursing woman.

Pediatric Use

The recommended dose in patients 6 to 11 years of age is based on cross-study comparison of the pharmacokinetics of ALLEGRA in adults and pediatric patients and on the safety profile of fexofenadine hydrochloride in both adult and pediatric patients at doses equal to or higher than the recommended doses.

The safety of ALLEGRA tablets at a dose of 30 mg twice daily has been demonstrated in 438 pediatric patients 6 to 11 years of age in two placebo-controlled 2-week seasonal allergic rhinitis trials. The safety of ALLEGRA for the treatment of chronic idiopathic urticaria in patients 6 to 11 years of age is based on cross-study comparison of the pharmacokinetics of ALLEGRA in adult and pediatric patients and on the safety profile of fexofenadine in both adult and pediatric patients at doses equal to or higher than the recommended dose.

The effectiveness of ALLEGRA for the treatment of seasonal allergic rhinitis in patients 6 to 11 years of age was demonstrated in one trial (n=411) in which ALLEGRA tablets 30 mg twice daily significantly reduced total symptom scores compared to placebo, along with extrapolation of demonstrated efficacy in patients ages 12 years and above, and the pharmacokinetic comparisons in adults and children. The effectiveness of ALLEGRA for the treatment of chronic idiopathic urticaria in patients 6 to 11 years of age is based on an extrapolation of the demonstrated efficacy of ALLEGRA in adults with this condition and the likelihood that the disease course, pathophysiology and the drug's effect are substantially similar in children to that of adult patients.

The safety and effectiveness of ALLEGRA in pediatric patients under 6 years of age have not been established.

Geriatric Use

Clinical studies of ALLEGRA tablets and capsules did not include sufficient numbers of subjects aged 65 years and over to determine whether this population responds differently from younger patients. Other reported clinical experience has not identified differences in responses between the geriatric and younger patients. This drug is known to be substantially excreted by the kidney, and the risk of toxic reactions to this drug may be greater in patients with impaired renal function. Because elderly patients are more likely to have decreased renal function, care should be taken in dose selection, and may be useful to monitor renal function. (See CLINICAL PHARMACOLOGY)

ADVERSE REACTIONS

Seasonal Allergic Rhinitis

Adults. [redacted]

were reported by greater than 2% of patients treated with fexofenadine hydrochloride tablets at doses of 180 mg once daily and that were more common with fexofenadine hydrochloride than placebo:

Table 1

Adverse experiences in patients ages 12 years and older reported in placebo-controlled seasonal allergic rhinitis clinical trials in the United States

Twice daily dosing with fexofenadine capsules at rates of greater than 1%

Adverse experience	*Fexofenadine 60 mg Twice Daily (n=679)*	*Placebo Twice Daily (n=671)*
Viral Infection (cold, flu)	2.5%	1.5%
Nausea	1.6%	1.5%
[redacted]hea	1.5%	0.3%
Drowsiness	1.3%	0.9%
[redacted]	1.3%	0.6%
Fatigue	1.3%	0.9%

Once daily dosing with fexofenadine hydrochloride tablets at rates of greater than 2%

Adverse experience	*Fexofenadine 180 mg once daily (n=283)*	*Placebo (n=293)*
Headache	10.6%	7.5%
Upper Respiratory Tract Infection	3.2%	3.1%
Back Pain	2.6%	1.4%

The frequency and magnitude of laboratory abnormalities were similar in fexofenadine hydrochloride and placebo-treated patients.

Pediatric. Table 2 lists adverse experiences in patients aged 6 to 11 years of age which were reported by greater than 2% of patients treated with fexofenadine hydrochloride tablets at a dose of 30 mg twice daily in placebo-controlled seasonal allergic rhinitis studies in the United States and Canada that were more common with fexofenadine hydrochloride than placebo.

Table 2

Adverse experiences reported in placebo-controlled seasonal allergic rhinitis studies in pediatric patients ages 6 to 11 in the United States and Canada at rates of greater than 2%

Adverse experience	*Fexofenadine 30 mg twice daily (n=209)*	*Placebo (n=229)*
Headache	7.2%	6.6%
Accidental Injury	2.9%	1.3%
Coughing	3.8%	1.3%
Fever	2.4%	0.9%
Pain	2.4%	0.4%
Otitis Media	2.4%	0.0%
Upper Respiratory Tract Infection	4.3%	1.7%

Chronic Idiopathic Urticaria

Adverse events reported by patients 12 years of age and older in placebo-controlled chronic idiopathic urticaria studies were similar to those reported in placebo-controlled seasonal allergic rhinitis studies. In placebo-controlled chronic idiopathic urticaria clinical trials, which included 726 patients 12 years of age and older receiving fexofenadine hydrochloride tablets at doses of 20 to 240 mg twice daily, adverse events were similar in fexofenadine hydrochloride and placebo-treated patients. Table 3 lists adverse experiences in patients aged 12 years and older which were reported by greater than 2% of patients treated with fexofenadine hydrochloride 60 mg tablets twice daily in controlled clinical studies in the United States and Canada and that were more common with fexofenadine hydrochloride than placebo. The safety of fexofenadine hydrochloride in the treatment of chronic idiopathic urticaria in pediatric patients 6 to 11 years of age is based on the safety profile of fexofenadine hydrochloride in adults and adolescent patients at doses equal to or higher than the recommended dose (see Pediatric Use).

Table 3

Adverse experiences reported in patients 12 years and older in placebo-controlled chronic idiopathic urticaria studies in the United States and Canada at rates of greater than 2%

Adverse experience	*Fexofenadine 60 mg twice daily (n=186)*	*Placebo (n=178)*
Back Pain	2.2%	1.1%
Sinusitis	2.2%	1.1%
Dizziness	2.2%	0.6%
Drowsiness	2.2%	0.0%

Events that have been reported during controlled clinical trials involving seasonal allergic rhinitis and chronic idiopathic urticaria patients with incidences less than 1% and similar to placebo and have been rarely reported during postmarketing surveillance include: insomnia, nervousness, and sleep disorders or paronina. In rare cases, rash, urticaria, pruritus and hypersensitivity reactions with manifestations such as angioedema, chest tightness, dyspnea, flushing and systemic anaphylaxis have been reported.

OVERDOSAGE

Reports of fexofenadine hydrochloride overdose have been infrequent and contain limited information. However, dizziness, drowsiness, and dry mouth have been reported. Single doses of fexofenadine hydrochloride up to 800 mg (six normal volunteers at this dose level), and doses up to 690 mg twice daily for 1 month (three normal volunteers at this dose level) or 240 mg once daily for 1 year (234 normal volunteers at this dose level) were administered without the development of clinically significant adverse events as compared to placebo.

In the event of overdose, consider standard measures to remove any unabsorbed drug. Symptomatic and supportive treatment is recommended.

Hemodialysis did not effectively remove fexofenadine hydrochloride from blood (1.7% removed) following terfenadine administration.

No deaths occurred at oral doses of fexofenadine hydrochloride up to 5000 mg/kg in mice (110 times the maximum recommended daily oral dose in adults and 200 times the maximum recommended daily oral dose in children based on mg/m²) and up to 5000 mg/kg in rats (230 times the maximum recommended daily oral dose in adults and 400 times the maximum recommended daily oral dose in children based on mg/m²). Additionally, no clinical signs of toxicity or gross pathological findings were observed. In dogs, no evidence of toxicity was observed at oral doses up to 2000 mg/kg (300 times the maximum recommended daily oral dose in adults and 530 times the maximum recommended daily oral dose in children based on mg/m²).

Prescribing Information as of November 2000

Aventis Pharmaceuticals Inc.
Kansas City, MO 64137 USA

US Patents 4,254,129; 5,375,693; 5,578,610

www.allegra.com 20118605/4020S0

alib1100Aa

ents do do goofy things. A few years after the Wallbergs' "flecking" debacle came the antiquing craze. My parents primed all my mismatched bedroom furniture in blood red and "antiqued" the pieces—from the bed and bureau to the wooden lamp stand and wardrobe—with streaks of brown paint. They even made a matching coffee table and tried to palm it off as a Japanese-style desk. I had to do my homework sitting on the floor.

The bed, with its pineapple-shaped posts, found its way to my house just about the time my toddler son was ready for a "big bed." At his request, I painted it a brilliant orange, but after nine years of a rough-and-tumble life that included a move to Europe and back, the antiqued blood-red surface is aggressively reasserting itself.

Donna Harrison

Lexington, Massachusetts

MOUNTED POLICE

WHILE ENJOYING A BEAUTIFUL JUNE day and a dense grad school textbook, sitting on the sloping grounds near the Washington Monument in the 1970s, I felt something touch the back of my neck. Thinking it was an insect, I casually swatted at it. I felt it again. I turned around and found myself face-to-muzzle with a U.S. Park Police horse. I asked the horse whether he wanted me to turn the page. He moved his head from side to side and, with his smiling officer, slowly walked away.

Paul Kaplan

Philadelphia, Pennsylvania

WRITE TO SMITHSONIAN

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Living Off the Land

ROBOTS THAT FEED THEMSELVES COULD BECOME SELF-PROPELLED FARM MACHINES—OR MILITARY SNIPERS

BY FRED HAPGOOD

David McFarland, John Greenman and Chris Melhuish, researchers at the University of the West of England, designed this robot to someday run on the slugs it catches.

POPULAR ARTICLES ON ROBOTICS usually focus on high-tech features like manipulators or vision or bipedality, but the people who actually have to build them worry a lot more about power. There are very few attractive options for machines that are supposed to run around untethered, especially if they have to do so outdoors. Batteries run out of charge, solar power arrays are cumbersome, internal combustion engines need to be refueled, and electrical outlets are few and far between.

This fact of life explains the unusual chain of associations Chris Campbell catalyzed with his exploding beer bottles. In 1996 Campbell was a graduate student in mechanical engineering at the University of South Florida and an enthusiastic amateur brewmaster. One day he forgot to vent some of his bottles properly and they blew up. Later that day he mentioned his experience to a roboticist named Stuart Wilkinson. "Aha!" the professor recalls thinking.

What he saw was that brewery energetics could be applied to solve the robot power problem. You could feed sugars to yeast, producing carbon dioxide (and alcohol), and then use the pressure of the CO_2 to turn wheels, moving the robot along. "We called it the flatulence engine," Wilkinson says with a grin, referring to a comparable process that takes place during animal digestion.

The point and virtue of the flatulence engine was that sugar exists naturally, in all vegetation, and vegetation is abundant, accessible, free and available 24 hours a day, rain or shine (at least outside of cities). A robot that could live off the land would have no more power worries than a goat. One obvious application would be gardening robots—mowers, trimmers, weeders—that would draw their power from digesting their own work product. Farmers might become entirely energy-independent, running all their machinery directly from a fraction of their crops. Mobile sensor platforms could be dispatched to wilderness areas for forest management, environmental monitoring and ecological research. There is a long line of people who might be interested in ocean going machines that could feed themselves by filtering algae or plankton from the water like baleen whales or that could sit on the bottom and live like clams. A bit further out, the machines might become the antibodies of an ecological immune system—equipped to detect and consume ecological invaders such as kudzu or Asian cheatgrass. Military applications would include robot snipers that could live in the woods, feeding on leaves and shrubs.

Rather quickly, however, Campbell

We're going to spend more time at the park.

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and Wilkinson were forced to conclude that while the flatulence engine was a breakthrough conceptually, it was not really practical. A useful robot would almost certainly have to have computers, a radio, navigation and warning lights, probably cameras, and possibly many other types of sensors. All these devices run off electricity, and that the flatulence engine, being mechanical, could not provide. (Mechanical energy can be converted to electrical, but the inefficiencies involved are depressing.)

Still, the idea focused his research, and soon Wilkinson stumbled on the work of a crusading British electrochemist named H. Peter Bennetto. Bennetto, now retired from King's College in London, had become an authority on biologically produced electricity.

As a result of metabolism, organisms generate a kind of electricity chemically, by making ions, or electrically charged atoms, inside cells. These ions then organize electron flows throughout the cell, bringing power to wherever it is needed. Bennetto discovered a chemical that could penetrate cell walls (in this case, those of microbes), absorb some of these electrons and then exit. Once outside the cell, the chemicals could be stimulated to shed the diverted electrons, creating an electrical gradient or potential. Possible applications include sustainable power plants in third world nations, harvesting electricity from bacterial cultures fed with local vegetation, and creating power from waste products at sugar refineries or dairy farms.

The discovery of Bennetto's microbial fuel cell (as the device is called) made Wilkinson confident enough to commit his work, for the moment, to the study and design of gastrobots—robots with stomachs. Today, Wilkinson has a simplified test device—basically a train with three 7- by 11-inch cars that is fed on refined sugar—running around a track in his lab. He calls it the gastronome.

The engineer says he gets a flow of mail from citizens worried that he is throwing away our leverage over robots, handing them the freedom they need to become the dominant species. It's bad enough that they will be able to feed themselves; suppose someday they develop a taste for meat? The energy content of animal protein and fat is far higher than that of vegetable matter. Suppose gastrobots took over the factories—which would no doubt be automated—that make them? Where would we be then? Driven into the dark corners of the world by tireless, implacable, flesh-eating machines. At least one really bad movie could be made about this idea.

There actually is a team in Bristol, England, developing a gastrobot that

It seems these robots (or rather the microbes that power them) need a balanced diet.

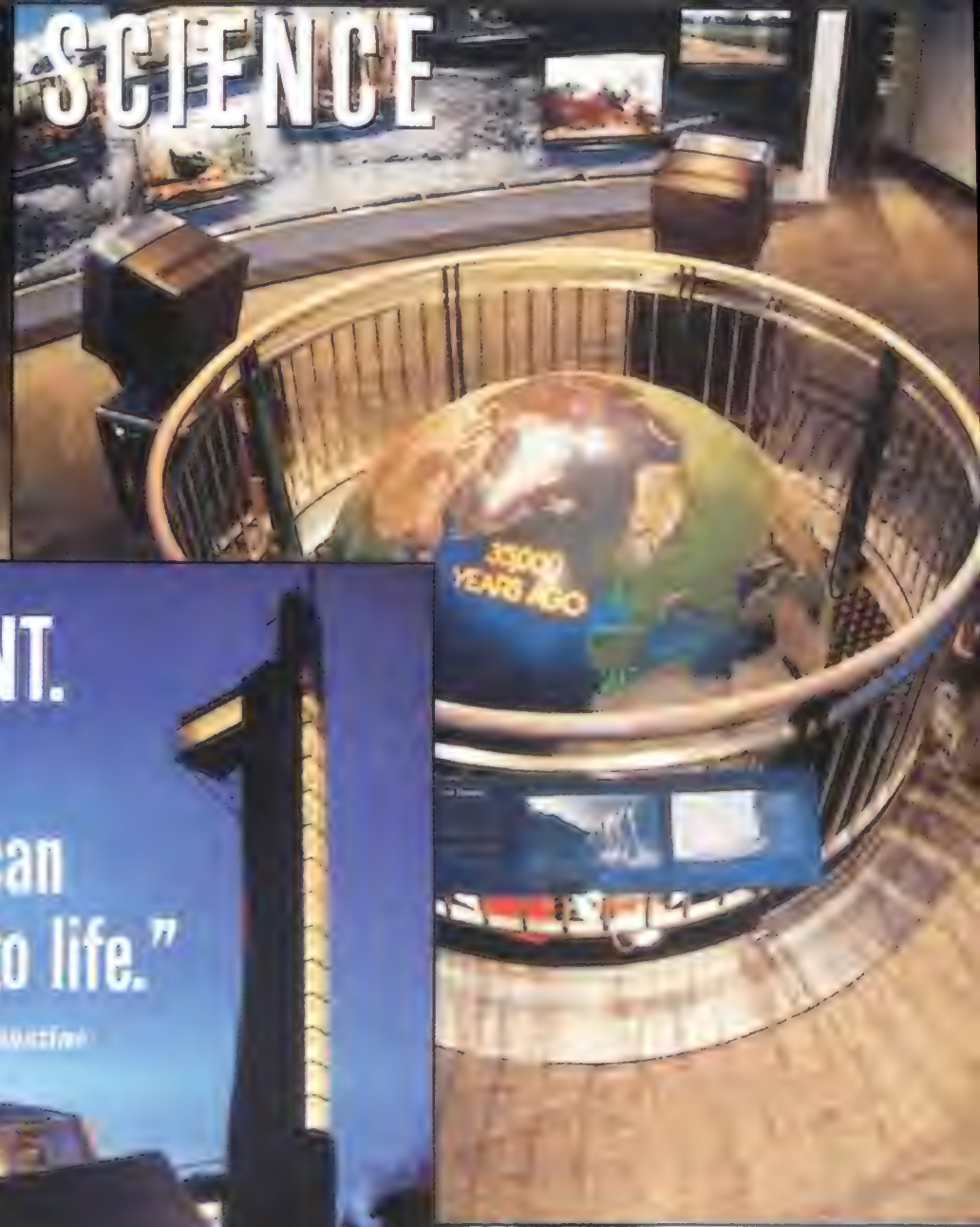
may someday be powered by meat, specifically that of slow-moving garden pests. They have already designed a mobile unit—the "slugbot"—that identifies and captures slugs. The device was designed to bring slugs back to a central digester, which would in turn power the robot.

Neither the slugbot nor the gastronome is heading outside anytime soon, however. Gastrobotics is a brand-new idea in mechanical engineering, and it raises a long list of issues. Primary, for the slugbot, is the problem of breaking down animal protein and fat: an important part of the puzzle for "flesh-eating robots" that hasn't been solved yet. It seems that these robots (or rather the microbes that would power them) need to have a balanced diet. "For them to digest all that meat, they need a bit of starch, or the odd leaf," says Chris Melhuish, one of the slugbot's creators, and part of a team that includes fellow researchers David McFarland and John Greenman.

But even for the vegetarian robot, an internal environment has to be designed that will keep the digesting microbes happy for months on end. The machines will need to distinguish between foods that will keep their microbes well and those that will kill them. Also, bacterial colonies yield more power if they are fed continuously rather than at different times during the day, which suggests that gastrobots will need precise senses of hunger and satiation. Wilkinson's gastronome now "consumes" pure sugar, creating very little waste, but once more complex carbohydrates (or meat) are involved, robots will have to have some mechanism for expelling waste. Ways must then be found to prevent the electron-transporting chemical from being excreted when the gastrobot relieves itself, so the machines will need a kidney.

Still, it does seem inevitable. The gastrobot combines two strong trends in modern technology: finding ways to harvest power from local sources (solar, wind, geothermal) and borrowing design ideas from biology. Today, engineers are building submarines that swim like fish, airplanes that get about by flapping their wings, and land vehicles that move by walking. One promising approach in artificial intelligence is neural nets, originally based on explicit analogies to the brain. The nature of progress in robotics and automation can be understood as de-domesticating machines; allowing them to operate on their own, eventually even to have original ideas. Gastrobots are another illustration of this deep trend toward blurring the ancient distinction between biology and engineering. Perhaps someday we will have wild machines roaming the landscape, self-sufficient, fully autonomous, answerable to no master but themselves and fate.

HISTORY



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POINTS OF INTEREST

Bed and Breakfast

MOST OF THE 256 SHELTERS ON THE APPALACHIAN TRAIL ARE PRETTY ROUGH. THEN THERE'S THE FONTANA HILTON

BY T. EDWARD NICKENS

As evening falls across the Great Smoky Mountains, tired hikers find respite in the Fontana Dam Shelter, which provides luxuries seldom associated with backpacking.

POPPOP IS POLISHING OFF A bowl of Lipton noodles and Spam when three more backpackers hobble down the hill. "Hey, lookee there," he says. He recognizes these fellows, passed them on the trail a few days back. "I can't believe you guys," he hollers out. "Y'all came all the way from Sassafras Gap? What was it, around 20 miles?"

"Twenty-two," groans a sinewy young man in a striped gray knit cap. He sports a scraggle of week-old beard and leans hard on trekking poles. Stumbling to the trail shelter, he folds like a rag doll. "Twenty-two miles," he mutters into grimy palms. His two companions shed their loads and shuffle, bent like spoons, to a nearby picnic table. Brodie Trickey is having a rough go. A hundred miles into the hike his right knee went bum. Now an Achilles tendon has swollen fat as a baseball bat. His buddy, Geoffrey Fender, is better off, but he's game on one leg, too, thanks to quarter-size heel blisters deep as ligament and the color of bad meat.

All three recent college graduates are sopping wet and smell like cadavers. They are almost out of food. But more than anything, they're happy to be here at the Fontana Hilton, one of the most famous shelters on the AT, as the Appalachian Trail is known to those who trek it.

Each year, nearly 3,000 backpackers set off from north Georgia's Springer Mountain bound for Maine's Mount Katahdin. It's a 2,168.1-mile journey that passes through 14 states, eight national forests and two national parks and crosses 15 major rivers. Fewer than one out of every five who start out will touch the summit of Katahdin, sometime in late summer, and claim the title of "thru-hiker."

I won't be one of them. I've come to the Great Smoky Mountains for a glimpse of AT culture, not exercise.

Tonight, hundreds of hikers will unroll their sleeping bags in the 256 trail shelters scattered all up and down the AT. Most are simple wood or stone structures, three-sided huts with a rough floor and unadorned platforms for sleeping. Some were built by Civilian Conservation Corps workers; a few are old ranger residences. Many have been erected in the past two decades to accommodate growing numbers of trail users.

Shelters are beloved and bemoaned by hikers. They are notoriously cold, frequently rodent-ridden and amplify every snore. But they turn strangers into neighbors, and rough wooden planks into community. Spending most of each day alone, many thru-hikers find shelters as memorable as any mountaintop view, and a major part of the AT experience.

Few if any are better known than the Fontana Hilton, which is officially designated the Fontana Dam Shelter. It's located 163 miles from Springer Mountain. Hikers arriving at Fontana have just crossed several of the steepest mountains on the trail. Make it to Fontana, and you have left some of the most grueling terrain behind you. Make it to Fontana, and the least prepared and the weakest of heart and hip flexor have been winnowed away. Make it to Fontana, and a shelter

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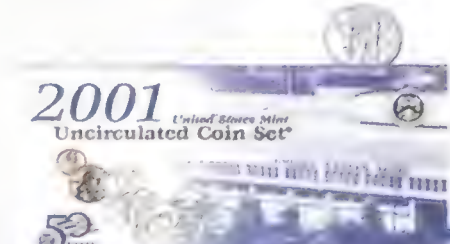

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awaits that is a cut above the rest, oversized, with a million-dollar view of fjordlike Lake Fontana, plus water spigots, flush toilets, free hot showers nearby and a $1 shuttle to an all-you-can-eat buffet. First, of course, you have to make it to Fontana.

PopPop limps over to the new arrivals. Most thru-hikers pick up a trail name during their first few weeks in the woods. PopPop's real name is Mike Higgins. He is a 54-year-old recently downsized futures broker from Charlotte, North Carolina—tall and big-boned, handsome and friendly. "You boys look like I feel," he says. He ruefully rubs his lower back and winces. "Come on in."

Already the shelter is redolent of sweat, candy bars, wet wool and stove fuel. It's a powerful perfume, and familiar. I may be a hanger-on today, but I'm no newcomer to shelter life. Once four of us, after enduring a -4 degree night in Virginia's Mount Rogers region, pounded our boots out of the frozen mud with mallets of frozen broccoli. And I'll never forget the midnight sight of an Old Orchard shelter mouse perched atop my buddy Robert's forehead, munching on a green M&M as Robert snoozed unaware. I've hiked parts of the AT from New Hampshire to northern Georgia, so I figure I belong with these folks, even though I'm not traveling with them. "Pretty rough out there today," I say to another bedraggled arrival as he strips off layers of wet clothing. He gives me the once-over. "Don't talk to me about rain, man," he says in a tired voice. "I see your boots." I look down. Clean as a whistle. Chastened, I slip into my sleeping bag.

Morning comes with sheets of rain, but the expected joys of nearby Fontana Village Resort make the weather a minor annoyance. Once the headquarters for construction crews at work on Fontana Dam, scores of worker's cottages have been renovated into small vacation cabins,

The shelter is a riot of rain jackets. Food bags hang from ceiling hooks like multicolored carcasses.

and the resort's buffets seem a sinful indulgence. After downing a hearty breakfast, I head into town with PopPop, Brodie, Geoffrey and their pal Shepherd, who carries a crook-necked hiking staff.

The village is taken over by hikers this time of year. They crowd the restaurant and a small grocery store filled with Lipton noodles, mac 'n' cheese, and 13 linear feet of Pringles potato chips. In the Laundromat, a dark-bearded guy plays a violin, while a small congregation of rain-gear-clad hikers stuff wet sleeping bags into dryers.

But the center of activity is the post office. Most thru-hikers resupply through carefully planned mailings to small Appalachian hamlets along the trail. Fontana is a major mail-drop station, and Brodie has hit the jackpot: he picks up a basketball-size box of resupply food, plus two more boxes and a pair of padded envelopes from friends back home. He tears into the cache like a wolf on carrion.

Behind the barred window, postmistress Virginia Zakroski grins. She relishes the thru-hiker season. "It's really slow the rest of the year," she says, "but oh, boy, not now." At times she'll have 200 boxes stacked, awaiting pick up. I point to a strawberries-and-cream air freshener, one of four hanging from hooks and window frames. Zakroski stymies a giggle. "Oh, yes, the hikers *do* smell," she says. "My regular customers will come in, wrinkle their noses, and say, 'Oooh, you've had hikers!'"

By the time we make it back to the Fontana Hilton, another eight backpackers have trickled in after hoofing through daylong downpours: Oz. YoLo. Marine One, 62 years old and tough as heart pine. Some skinny kid with a dog named Doobie. Rabbit. Brooklyn. A young married couple. The shelter is a riot of rain jackets, mud-slimed gaiters, pack covers, hats, gloves. Food bags hang from ceiling hooks like multicolored carcasses.

After supper, we retreat to our sleeping bags. With backs against the shelter's pine-plank walls, the group—now two dozen strong—begins to gel into a genuine community, if only for the night. Oz tells a story

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A pair of happy campers tear into packages that were waiting for them at the post office when they arrived. During the peak hiking season, up to 20 packages arrive daily.

about "Yogi-ing," the thru-hikers' practice of sidling up to picnickers with a pathetic look, mooching handouts. There's a round of recipe trading. "You know what's good?" someone says. "Instant mashed potatoes mixed with ramen noodles. Now, that's good." Murmurs of appreciation. Geoffrey returns, wide-eyed, from the bathhouse. "Have you been in there?" he asks. "It's like Saks Fifth Avenue!" There's a brief discussion of chafing and its myriad solutions.

But mostly the talk is about trail companions left behind. PopPop hasn't seen Serge in a couple of days, and Rabbit is wondering if anyone has run into Creeper. What about Miracle Mike? "Saw him last night at Wesser Bald." Slipknot? Scruffy Sleeper? Sea Wolf? "Anybody seen PowerBar?" someone asks from the dark. There are howls all around. Seems that one thru-hiker figured he'd save the weight and trouble of cooking on a stove, and packed nothing but high-energy snack bars. "He figured out how many calories he needed a day, and divvied it up," the voice explains. The fellow ate 17 PowerBars a day until his guts shut down. He hasn't been seen in a week.

A flask of bourbon bounces around on one side of the shelter; on the other, the orange tip of a glowing joint slips from one sleeping bag to the next. The shelter grows quiet. PopPop pulls out a harmonica and sends out a few lonesome strains of "Dixie," but soon the only sound is the rustle of bodies turning inside their nylon chrysalides. And the first snores, bane of shelter life. Geoffrey calls out the evening's final hurrah, like the last "g'night" on Walton's Mountain. "Hey, PopPop—you take your Metamucil yet?"

The hikers unfold from their sleeping bags, joints and muscles stiff as taffy. They move like praying mantises.

In the morning, I wake up to the wail of a loon on Fontana Lake. The skies are the color of old fish. Thunder grumbles. The hikers unfold from their sleeping bags, joints and muscles stiff as taffy. They move like praying mantises. "Mercy," Shepherd intones, to no one in particular.

I walk over to the far bunk. "What do you think, guys?"

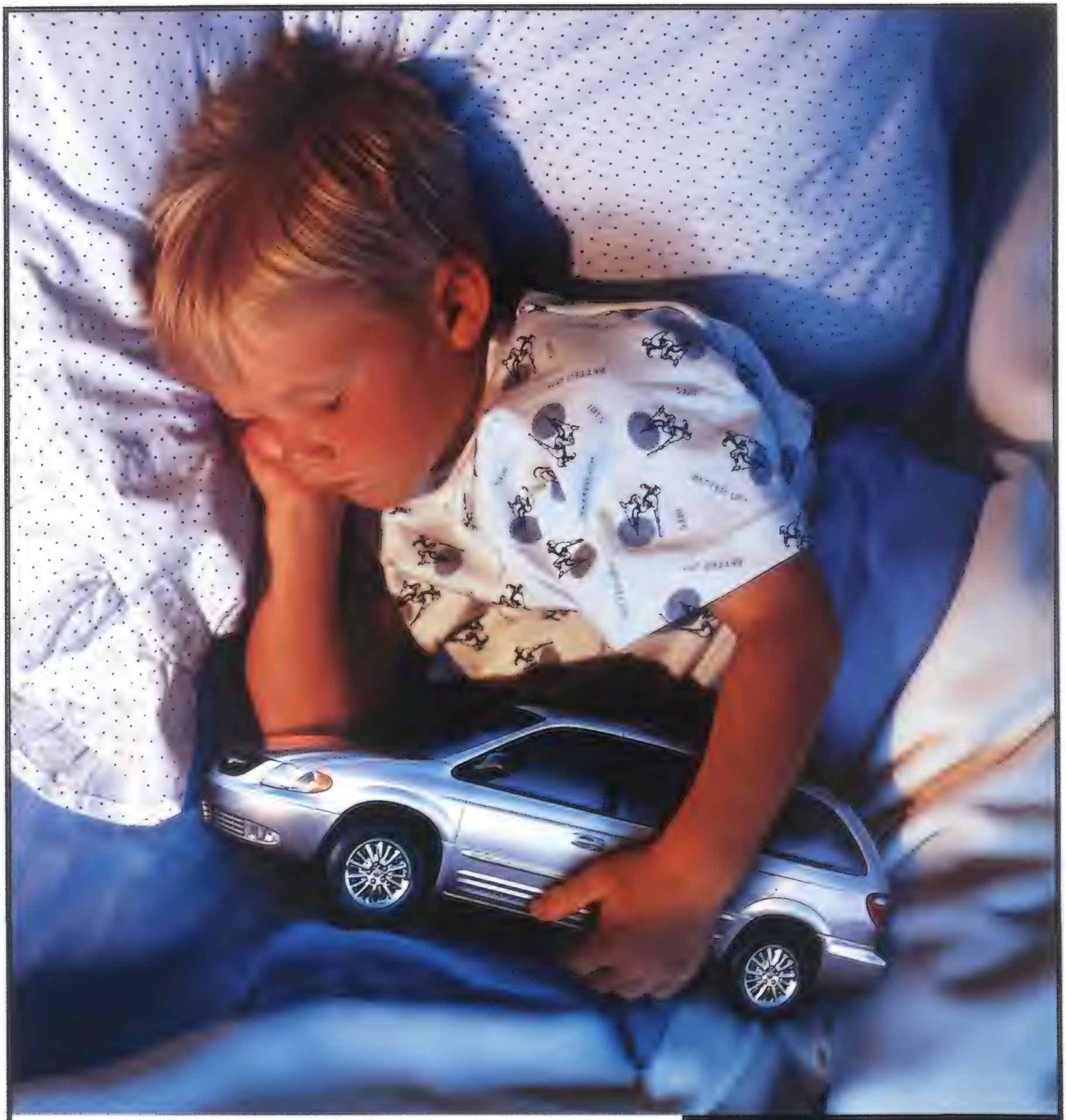
Brodie winces. Geoffrey is stoic. "Put us on the injured reserve list one more day," he says. They're young, resolute and unemployed. Another day of rest, I figure, and they'll be back on their way to Maine. I dig out a bottle of ibuprofen and pour a few dozen pills into Brodie's hand. I wish him luck, then strike out with PopPop, heading north on the trail.

From the Fontana Hilton the AT tracks a mile or so of hard-surface road, then crosses over the top of Fontana Dam. The morning fog is thick as gauze. We're on a catwalk through the clouds. The arched back of the Great Smokies' ridgeline has disappeared, yet I can feel its ancient bulk above us. Climbing and crossing the Smokies is a weeklong undertaking that entails solitude, grandeur and difficulty. PopPop is pensive.

He's hardly stopped moving in the last year, he tells me, ever since joining the ranks of the downsized. "I haven't done much in terms of *work*," he explains. "But I've sailed across the Atlantic Ocean in both directions, and in five months I'll be able to say I've walked the AT. That ought to be worth a couple of checks in life's ledger book."

On the far side of the dam, the trail turns off an asphalt service road and reenters the woods. Once more the AT is the familiar white-blazed path, a foot-and-a-half wide and as long as you can take it.

The moment lingers. PopPop checks to make sure I have his 80-year-old mother's e-mail address, and makes me promise twice to write her. He frets about Brodie's foot, and wonders if he'll see his trail pal Serge again. Sometime today, he says, he'll pass the 168.1-mile mark. "Only 2,000 miles to go," he grins. And then he turns and slowly treads uphill. "I'll call you in September," he says over a shoulder, as I scribble a note about the sound of a warbler singing in the wet woods. I want to tell him that I look forward to hearing if he made it to Katahdin, or to some more meaningful summit. But when I lift my head, he's gone.



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IMPORTANT INFORMATION ABOUT VIOXX.

In rare cases, serious stomach problems, such as bleeding, can occur without warning. People with allergic reactions, such as asthma, to aspirin or other arthritis medicines should not take VIOXX.

Tell your doctor if you have liver or kidney problems, or are pregnant. Also, VIOXX should not be used by women in late pregnancy.

VIOXX has been extensively studied in large clinical trials. Commonly reported side effects included upper respiratory infection, diarrhea, nausea and high blood pressure. Report any unusual symptoms to your doctor.

ASK YOUR DOCTOR OR HEALTHCARE PROFESSIONAL ABOUT VIOXX.

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You should read this information before you start taking VIOXX*. Also, read the leaflet each time you refill your prescription, in case any information has changed. This leaflet provides only a summary of certain information about VIOXX. Your doctor or pharmacist can give you an additional leaflet that is written for health professionals that contains more complete information. This leaflet does not take the place of careful discussions with your doctor. You and your doctor should discuss VIOXX when you start taking your medicine and at regular checkups.

What is VIOXX?

VIOXX is a nonsteroidal anti-inflammatory drug (NSAID) that is used to reduce pain and inflammation (swelling and soreness). VIOXX is available as a tablet or a liquid that you take by mouth.

VIOXX is a medicine for:
- relief of osteoarthritis (the arthritis caused by age-related "wear and tear" on bones and joints)
- management of acute pain in adults (like the short-term pain you can get after a dental or surgical operation)
- treatment of menstrual pain (pain during women's monthly periods).

Who should not take VIOXX?

Do not take VIOXX if you:
- have had an allergic reaction such as asthma attacks, hives, or swelling of the throat and face to aspirin or other NSAIDs (for example, ibuprofen and naproxen).
- have had an allergic reaction to rofecoxib, which is the active ingredient of VIOXX, or to any of its inactive ingredients. (See Inactive Ingredients at the end of this leaflet.)

What should I tell my doctor before and during treatment with VIOXX?

Tell your doctor if you are:
- pregnant or plan to become pregnant. VIOXX should not be used in late pregnancy because it may harm the fetus.
- breast-feeding or plan to breast-feed. It is not known whether VIOXX is passed through to human breast milk and what its effects could be on a nursing child.

Tell your doctor if you have:
- kidney disease
- liver disease
- heart failure
- high blood pressure
- had an allergic reaction to aspirin or other NSAIDs
- had a serious stomach problem in the past.

Tell your doctor about:
- any other medical problems or allergies you have now or have had.
- all medicines that you are taking or plan to take, even those you can get without a prescription.

Tell your doctor if you develop:
- ulcer or bleeding symptoms (for instance, stomach burning or black stools, which are signs of possible stomach bleeding).
- unexplained weight gain or swelling of the feet and/or legs.
- skin rash or allergic reactions. If you have a severe allergic reaction, get medical help right away.

How should I take VIOXX?

VIOXX should be taken once a day. Your doctor will decide what dose of VIOXX you should take and how long you should take it. You may take VIOXX with or without food.

Can I take VIOXX with other medicines?

Tell your doctor about all of the other medicines you are taking or plan to take while you are on VIOXX, even other medicines that you can get without a prescription. Your doctor may want to check that your medicines are working properly together if you are taking other medicines such as:
- methotrexate (a medicine used to suppress the immune system)
- warfarin (a blood thinner)
- rifampin (an antibiotic)
- ACE inhibitors (medicines used for high blood pressure and heart failure)
- lithium (a medicine used to treat a certain type of depression).

What are the possible side effects of VIOXX?

Serious but rare side effects that have been reported in patients taking VIOXX and/or related medicines have included:

- Serious stomach problems, such as stomach and intestinal bleeding, can occur with or without warning symptoms. These problems, if severe, could lead to hospitalization or death. Although this happens rarely, you should watch for signs that you may have this serious side effect and tell your doctor right away.
- Serious allergic reactions including swelling of the face, lips, tongue, and/or throat which may cause difficulty breathing or swallowing occur rarely but may require treatment right away. Severe skin reactions have also been reported.
- Serious kidney problems occur rarely, including acute kidney failure and worsening of chronic kidney failure.
- Severe liver problems, including hepatitis and jaundice, occur rarely in patients taking NSAIDs, including VIOXX. Tell your doctor if you develop symptoms of liver problems. These include nausea, tiredness, itching, tenderness in the right upper abdomen, and flu-like symptoms.

In addition, the following side effects have been reported: confusion, hair loss, hallucinations, low blood cell counts, unusual headache with stiff neck (aseptic meningitis).

More common, but less serious side effects reported with VIOXX have included the following:

Upper and/or lower respiratory infection and/or inflammation
Headache
Dizziness
Diarrhea
Nausea and/or vomiting
Heartburn, stomach pain and upset
Swelling of the legs and/or feet
High blood pressure
Back pain
Tiredness
Urinary tract infection.

These side effects were reported in at least 2% of osteoarthritis patients receiving daily doses of VIOXX 12.5 mg to 25 mg in clinical studies.

The side effects described above do not include all of the side effects reported with VIOXX. Do not rely on this leaflet alone for information about side effects. Your doctor or pharmacist can discuss with you a more complete list of side effects. Any time you have a medical problem you think may be related to VIOXX, talk to your doctor.

What else can I do to help manage my osteoarthritis pain?

Talk to your doctor about:
- Exercise
- Controlling your weight
- Hot and cold treatments
- Using support devices.

What else should I know about VIOXX?

This leaflet provides a summary of certain information about VIOXX. If you have any questions or concerns about VIOXX, osteoarthritis or pain, talk to your health professional. Your pharmacist can give you an additional leaflet that is written for health professionals.

Do not share VIOXX with anyone else; it was prescribed only for you. It should be taken only for the condition for which it was prescribed.

Keep VIOXX and all medicines out of the reach of children.

Inactive Ingredients:

Oral suspension: citric acid (monohydrate), sodium citrate (dihydrate), sorbitol solution, strawberry flavor, xanthan gum, sodium methylparaben, sodium propylparaben.

Tablets: croscarmellose sodium, hydroxypropyl cellulose, lactose, magnesium stearate, microcrystalline cellulose, and yellow ferric oxide.

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Folklife's Cultural Triangle

SMITHSONIAN HIGHLIGHTS

THE HISTORY AND TRADITIONS OF BERMUDA, the cultural diversity of New York City and the crafts of the building trades are the focus of the Smithsonian's 35th annual Folklife Festival, held on the Mall from June 27 through July 1 and July 4 through July 8.

The festival examines the way the islanders on the tiny archipelago of Bermuda have incorporated components from myriad cultures and from the land to add a distinct flavor to their arts, crafts and celebrations. Concerts showcase the way Bermudians lend a unique sound to reggae, calypso, jazz and gospel. Their 200-year tradition of performances by masked, costumed dancers, called Gombeys (above), is a contribution from the Caribbean. Cup Match, a cricket game normally played on the national holiday celebrating the end of slavery in Bermuda, will be demonstrated. Their use of native limestone to build houses, local cedar to create furniture and banana leaves to make dolls is also explored.

Sights from New York City include a real water tower (there are some 10,000 in New York) and the "Red Bird," an authentic 1960s subway car. The city's status as the global capital of finance, the arts, and fashion, is reflected by traders from Wall Street, by Broadway chorus lines and by fashion designers. And on July 7, Harlem's famed Apollo Theater will bring its Amateur Night entertainment contest to the Mall. (Auditions will be held on July 6. For more information, visit: www.si.edu/folklife.)

The creation of buildings hinges on skills that are often passed from generation to generation. Eighty artisans, including metal and wood workers, masons, carpenters and more, will demonstrate their crafts. —*Lucinda Moore*

SMITHSONIAN

HIGHLIGHTS

Exhibitions and Events

NATIONAL MUSEUM OF NATURAL HISTORY

The IMAX & Jazz Café (Every Friday, 5:30-10 P.M., through September 3) Enjoy dinner, live jazz and films.
The Immersion Cinema (permanent) Features floor-to-ceiling, 48-foot-wide, 150-degree wraparound screens, as well as 50 interactive consoles that allow the audience to determine how the adventure unfolds.

ART NIGHT ON THE MALL

The Sackler and Freer galleries and the Hirshhorn and African Art museums will remain open until 8 P.M. Thursdays, through August 30 (see www.si.edu/activity/artnight).

GEORGE GUSTAV HEYE CENTER, NATIONAL MUSEUM OF THE AMERICAN INDIAN [NEW YORK CITY]

Seth Eastman Watercolors: A Soldier Artist Among the Dakota (through October 7) Fifty-six paintings document mid-19th-century Dakota life.

ARTS AND INDUSTRIES BUILDING

Game Face: What Does a Female Athlete Look Like? (through December 16) Photographs of female athletes of diverse races, ages, physical abilities.
Brain: The World Inside Your Head (July 14 through January 2, 2002) The basic workings, evolution and development of the brain, and the nature of sleep and consciousness.

HIRSHHORN MUSEUM AND SCULPTURE GARDEN

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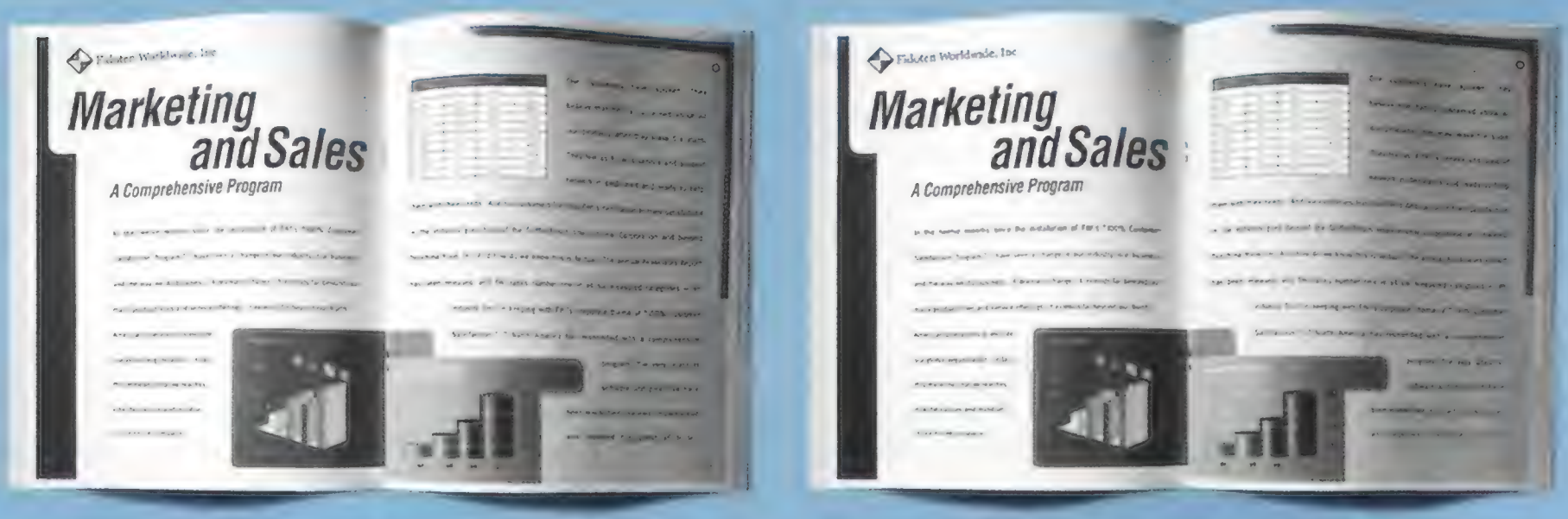

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IN A MESSAGE BOTTLE

BY STUDYING OBJECTS CAST UP ON OUR SHORES, RESEARCHER CURTIS EBBESMEYER TRACES THE FLOW OF OCEAN CURRENTS

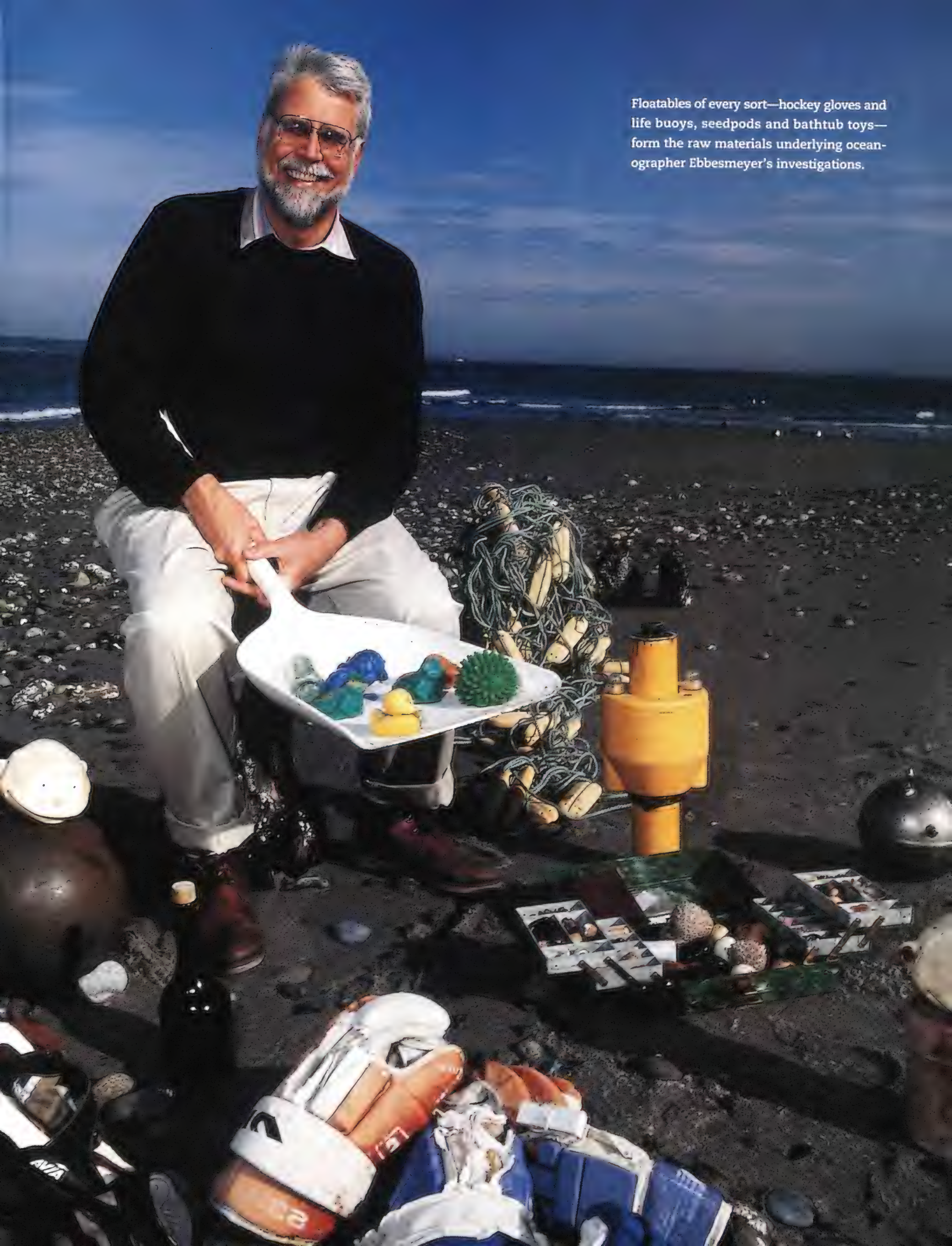
IF CURTIS EBBESMEYER HAD just one word for budding oceanographers, it would probably be: plastics. If he had more than one, he might add: roll-on antiperspirant balls, toxic-waste containers, computer monitors, lightbulbs, armadas of toys and sporting goods, toilet seats, bales of rubber and marijuana, explosive devices, surfboards, coconuts, aircraft, the occasional human body, and a surprising number of genuine messages in bottles. The seas are wonderfully, horribly full of floating things. Sooner or later, many of them wash up on the beach; and on the way, some make epic continent-to-continent journeys, thus forming new data points regarding the complex doings of long-distance ocean current systems—the subject of Ebbesmeyer's work.

Scientists study currents ever more intensely: they affect not only transportation but weather, biology, evolution and climate change. Most oceanographers use satellites and high-tech buoys for tracking them; Ebbesmeyer, a self-described "filter feeder on floating objects," stubbornly does it the old-fashioned way—by studying movements of random junk. Part reporter and historian, part water physicist, he has sources everywhere, including his own vast, ragtag worldwide army of beachcombers. "The literature of things that float from here to there is so scattered it makes no sense until you compress it," he says. "Then it begins to take on a glow, like radium."

His contributions to the literature range from the seminal to the semi-wacky, but we know one thing: he is probably the only scientist to have posed for *People* magazine mostly naked (grayed in the chest hairs, but looking good) in the pool with a floating bathtub ducky, a souvenir of one of his greatest research triumphs. Colleagues with fancier instruments and stiffer attitudes may sneer, but deep down they must suspect the truth: he has more fun than they do. Along the way, he has learned that ocean surface currents can be chaotically changeable; if two bathtub toys are dumped, say, in the middle of the Pacific at the same moment in the same spot, one may wash up in Hawaii while the other might end up frozen in an Arctic ice floe.

I accidentally entered the world of long-distance floatables on a Canadian Coast Guard icebreaker traversing the Northwest Passage—that frozen labyrinth of islands where Arctic ice floes slowly drain toward the Atlantic. In this treeless region, I was watching off the bow one day for polar bears and instead spied dead

BY KEVIN KRAJICK ◆ PHOTOGRAPHS BY RICK RICKMAN



Floatables of every sort—hockey gloves and life buoys, seedpods and bathtub toys—form the raw materials underlying oceanographer Ebbesmeyer's investigations.

Peripatetic beachcomber Steve McLeod, displaying a glass fishing float and other finds, has served as a roving data collector for Ebbesmeyer.

ahead a weathered tree fragment in the ice. Eddy Carmack, an onboard oceanographer specializing in water movements such as eddies, assured me this was normal. "Trees fall off banks of north-flowing Siberian and Canadian rivers," he said. "Then they move into the sea ice. They may go around clockwise with the Transarctic Drift"—a great gyre circling the Arctic Ocean—"for 30 years. Eventually, the tree gets spit out near Greenland. If it's not too waterlogged, maybe then it circles the Atlantic for a while. Maybe it lands in England or North Carolina, then somebody puts it on the mantel. There's a lot of odd stuff like that." Carmack jotted down the Seattle phone number of Curt Ebbesmeyer—the man he said knew the most about such odd stuff.

Ebbesmeyer got started in the mid-1960s with Mobil Oil as a roustabout, then, after attending the University of Washington, an oceanographer. A lot of Mobil's oil was under the frigid Grand Banks off Newfoundland; Ebbesmeyer was told to figure out how to tow approaching icebergs—the largest floating objects in the world—away from drilling platforms. In 1974 he joined Evans-Hamilton, Inc., a small oceanographic consulting firm specializing in measuring and understanding ocean currents. His projects have included placing sewage outfalls to minimize impact on shore ("Did you know 10 percent of sewage floats even after secondary treatment?") and tracking oil slicks (of his work on the Exxon *Valdez* spill: "Did you know oranges are good experimental surrogates? For some reason, if you dump thousands in seawater, they'll distribute themselves exactly like spilled oil").

Each ocean, carrying the long-distance floatables studied by Ebbesmeyer, hosts one or more huge gyres shaped by prevailing winds, Earth's rotation and bordering landmasses. The Gulf Stream, skirting the U.S. East Coast, is part of a clockwise pattern of surface currents that carries Caribbean debris past Nantucket, toward Iceland, to the coasts of Norway and Britain, around the calm center of the Sargasso Sea, and back again. In the Pacific, the Kuroshio, or Japanese, Current arcs clockwise away from Japan and becomes the North Pacific Drift, then turns south 200 to 500 miles off Washington or Oregon, where it is called the California Current. Off Baja California, it turns back out, passing Hawaii, heading for the Philippines and China, and back to Japan. An object may take six years to complete the roughly 14,000-mile circuit.

Unless sidetracked in any of countless ways. Storms drive floaters off track, especially ones with windage—exposed surface area making a sail—into countercurrents or competing gyres, like the North Pacific's counterclockwise Alaska Current, which can snag something from the Pa-

cific Northwest and send it toward Siberia, or filter it through the teeth of the Aleutians to be sucked through the Bering Strait and into the swirling belly of the Arctic. Alternatively, junk may hang out for years if it drifts into the eyes of the great oceanic gyres. Also, strong winds can cause water masses to upwell or downwell powerfully, which is reflected both in surface movements and in huge worldwide submarine currents that flow their own separate ways—a whole other story.

It is also becoming apparent that major surface current systems, once thought stable as rocks, are capable of huge, sudden shifts. In the prehistoric past, these could have been the result—or cause—of drastic climate change; many scientists think that cycle could recur, with dire results. Oceanic distributions of nutrients depend on currents; hitchhiking on currents is integral to the life cycles of everything from eels to sharks. There's also evidence that even large terrestrial animals may spread and evolve by the unlikely mechanism of "rafting" on ocean debris.

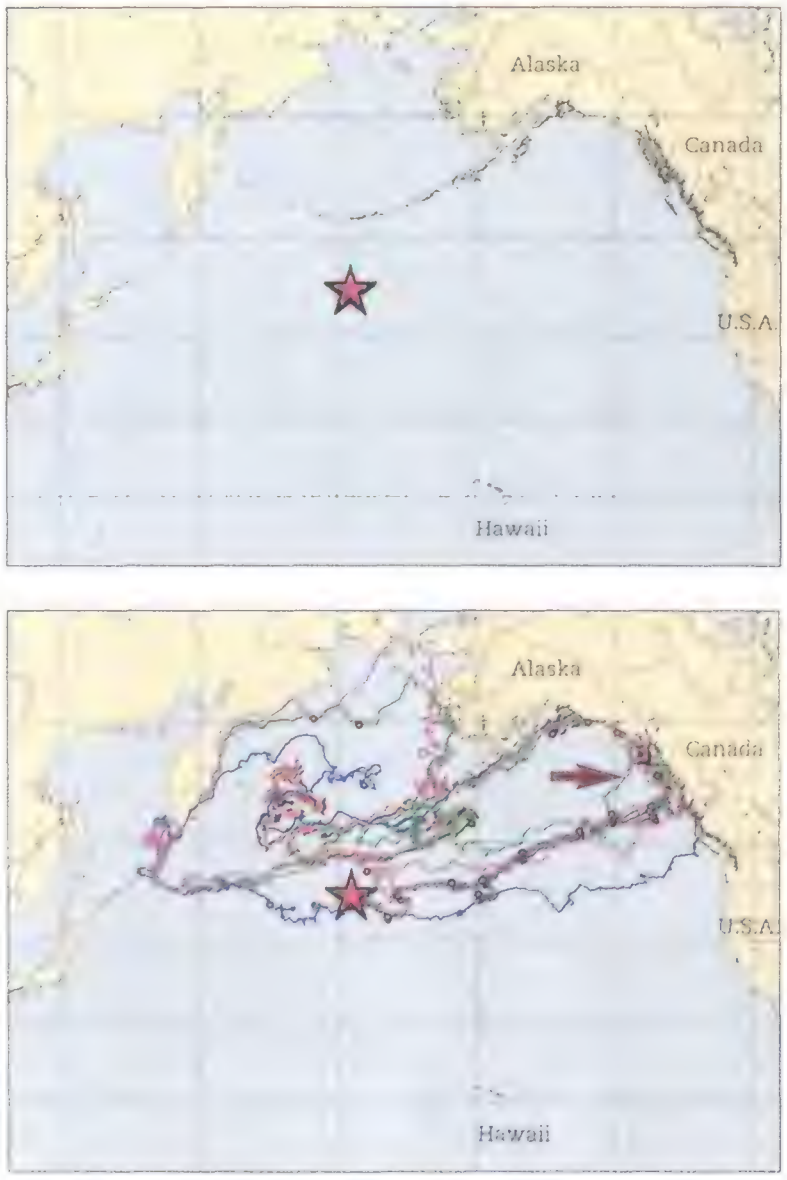
It seems unlikely also that any small human-made object can survive a long voyage, make it to a beach and stay long enough for someone to come along at just the right moment to discover it. But objects do. Boy, do they.

In 1959, the Guinness brewing company of Dublin dumped 150,000 of its bottles into the Atlantic and Caribbean, each containing a scroll bearing greetings from "King Neptune" extolling Guinness and providing instructions for converting the bottle into a lamp. They were so well sealed with cork, wax and lead tape, Guinness predicted they would go 500 years. According to one of Ebbesmeyer's sources, about 80 bottles made it to Coats Island in Canada's Hudson Bay, to be spotted by Inuit hunters. The mystified Inuit used the bottles for target practice, but then saw the scrolls and buried the rest in an unmarked grave.

Ebbesmeyer loves such arcana, but must admit that his first love is garbage. There is so much of it. And most is plastic. The buoyant, indestructible stuff has exploded since the 1950s and '60s; before that most marine garbage was organic, so it eventually rotted or sank. The bulk may come from land, dumped offshore or floated out rivers, but ships contribute much. Lost synthetic fishing gear alone—nets, traps, buoys, lines, packing material—may run 150,000 tons a year. More is washed or thrown off merchant and pleasure vessels, despite a 1987 international convention supposedly curbing marine dumping. As many as 1,000 or more boxcar-size shipping containers—perhaps the most fruitful sources of intriguing objects—fall off ships annually, releasing fleets of floatable goods.

The results are horrifying. In some years tens of thousands of seals and hundreds of thousands of seabirds may die entangled in lost fishing gear. Turtles, whales, fish and

BATHTUB TOYS' DRIFT



In 1992 a container ship spilled 29,000 bath toys into the Northern Pacific (star, top). After 400 were found (arrow, middle), oceanographer James Ingraham used a computer model to track the objects' route and extrapolate where the remainder would go. Minor currents would push these floatables along myriad paths, indicated here by individual colored lines. The center chart projects the toys' travels through 1995; the bottom, through the end of last year.

JIM INGRAHAM/NOAA/NATIONAL MARINE FISHERIES SERVICE (3)

On Oregon's Indian Beach, collector Barry Tweed sports Nikes from the 1990 spill that became a subject of scientific inquiry.

at least 100 seabird species mistake plastics for floating food: autopsied animals are often crammed with cigarette lighters, plastic bags, tampon applicators, toy soldiers. Old plastics break up under ultraviolet radiation and waves, but never die; they turn into "nurdles"—colorful, anonymous fingernail- to BB-size bits. The ocean keeps trying to cleanse itself of them like a cold sufferer spitting phlegm. After a recent count, the Southern California Coastal Water Research Project estimated there were more than one million per mile along Orange County beaches. "To my horror and fascination, plastic trash just keeps going," says Ebbesmeyer. "It is both sinister and useful."

Others have long put floatables to work for science. Eighteenth- and nineteenth-century explorers figured out the outlines of major currents simply by watching where objects traveled, including their own vessels. Today, scientific institutions are deploying the latest tracking devices: a planned fleet of 3,000-some PALACE floats, or Profiling Autonomous Lagrangian Circulation Explorers. These drifters automatically sample salinity and temperature—also measures of water movements—and dive on programmed schedules as deep as a mile to catch various current layers, surfacing occasionally like U-boats to transmit data to satellites. But instruments like these cost thousands of dollars apiece and are, by necessity, deployed in limited numbers.

Which brings us back to floating junk—and to Curt Ebbesmeyer. For years he labored at his consulting firm in Seattle but never quite managed to grow up; endlessly curious, Ebbesmeyer did extracurricular thinking on everything from migratory shad to the origin of life. He and a group of colleagues were the first to point out that a single, sudden 1976 Pacific climate/circulation swing had affected dozens of seemingly unconnected phenomenon, including West Coast water-oxygen contents, Arctic sea-ice extents, Andean glacial dynamics; life cycles of corals, crabs, oysters, salmon. He collected this data from existing studies, like so much beachcombed drift; the resulting publication became a key paper on climate change.

Field science was about to take over Ebbesmeyer's life, beginning one day in May 1991, when his mother, Genevieve, was serving lunch and reading from the paper. Factory-fresh Nike sneakers and hiking boots were washing up on Oregon beaches—so many that beachcombers were holding swap meets to match lefts with rights of correct sizes for selling or for wearing. No one knew the source. "Curt, isn't that your business to figure out things like that?" inquired Genevieve. Some hours later the phone rang at a home in coastal Rockaway Beach, Oregon, where

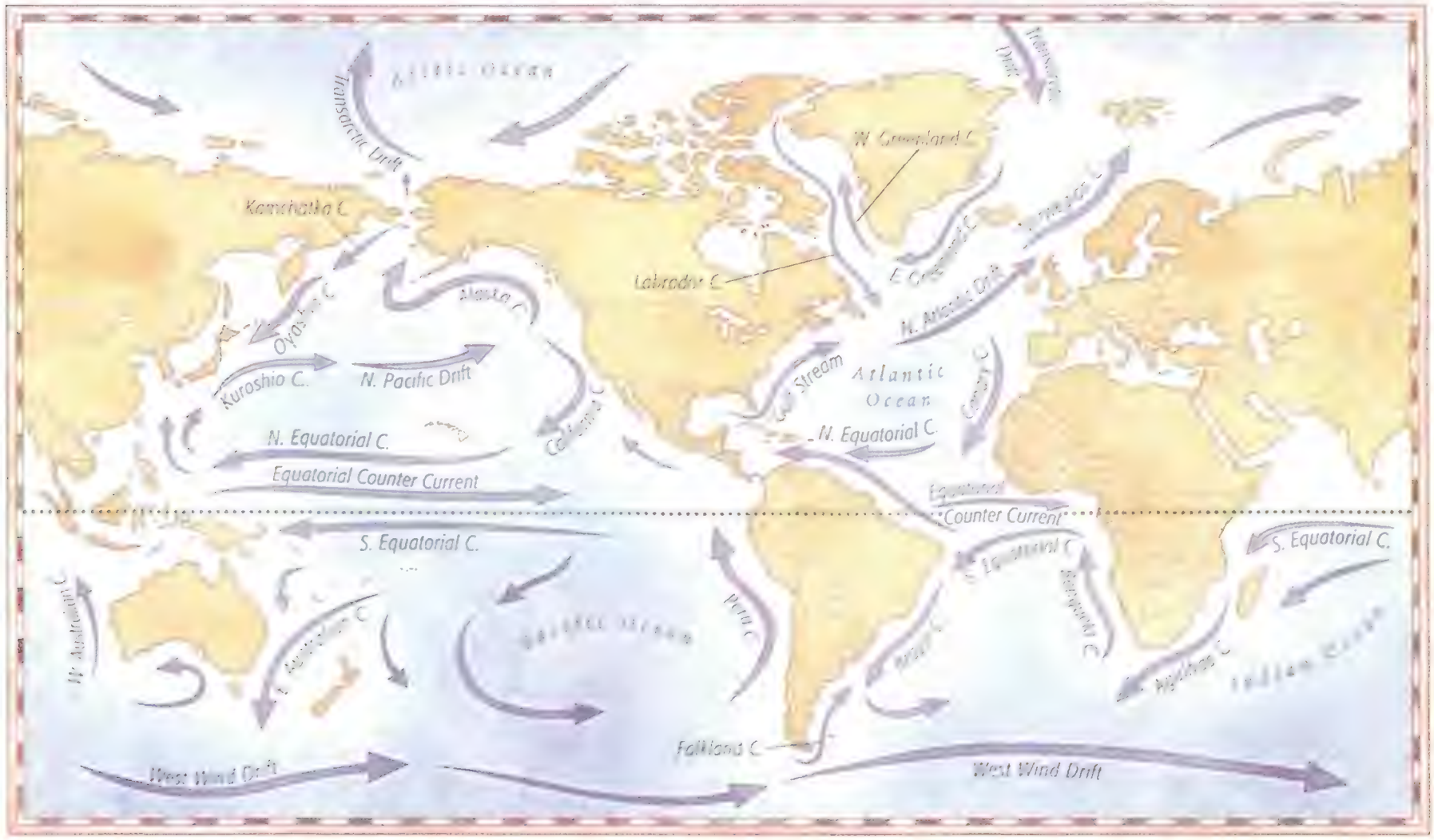
a swap meet was in progress. It was Curt Ebbesmeyer.

Thus began a brilliant new incarnation for the oceanographer—and for beachcomber/artist Steve McLeod, mightiest Nike hunter of them all. Converging currents and winds make the Pacific Northwest one of the world's most productive beachcombing regions, and thus host to a longtime secret society of serious beachcombers. The big prizes: old glass fishing-net floats, handblown in Japan and ranging from golf-ball-size and smaller to bigger than a medicine ball. The rarest are worth at least $3,000; there are also crab pots, ship parts and many other resalable objects. Pros monitor 24-hour weather radio for two or three days of winds from the south to move debris in from the main oceanic gyre, hobnobbing with fishing captains for intelligence on offshore sightings. Storms, of course, are prime time. Combers wait for high tide—even if it's at 3 A.M.—then climb down crumbly cliffs to dot beaches with lanterns, flashlights, floodlights and headlights; pickup trucks rove surf lines on accessible stretches.

No one knows who found the first Nikes, but McLeod collected his initial batch of about 20 along and near Crescent Beach, a wild stretch of sand flanked by cliffs near his home in Cannon Beach, Oregon. The 56-year-old ex-coast guardsman had long ago dropped out of the "consumerist economy" to pick chanterelles in the woods and sell salvaged fishing floats; he saw an opportunity here. His size nine hiking boots were worn out, and here was an expensive new size nine Nike—albeit only a left, encrusted with barnacles. Combers are generally secretive, but this time they needed each other. One woman mentioned the Nikes to a local television reporter and the news spread. People put the shoes in washers with bleach. Ensuing swap meets featured mounds of Nikes. Soon McLeod had new boots on both feet, plus a stock of extras that eventually netted him about $1,300, at around $20 a pair.

Things really got going with the appearance of "Dr. Curt," as they called him. For him, this was not about the money. It took half a dozen phone calls to find McLeod, and a dozen or so more brought him to Nike's transportation manager. The man told him—as Ebbesmeyer suspected—that Nike had lost a load of shoes in a shipping accident; the courts were ironing it out. "They're washing up now. Do you want them back?" asked Ebbesmeyer. He was told, not surprisingly, that he and the beachcombers could keep them. Here, thought Ebbesmeyer, is the best drift experiment anyone could dream of.

Phoning shipping lawyers, he got court papers with baseline data: the ship was the *Hansa Carrier*, en route



Each of the oceans is home to one or more huge gyres, formed by the major surface current systems. These currents, shown above in their average locations and directions, are driven primarily by prevailing winds and Earth's rotation.

KAREN MINOT

John Anderson has recovered an array of glass fishing floats (he holds his favorite; his rarest is by his foot), along with countless foam buoys that cover a 40-foot post in his yard.

from Korea, hit by a storm on May 27, 1990, at 48 degrees north, 161 degrees west. Twenty-one containers were swept off deck; five held 80,000 Nikes. Each Nike tongue had a telltale serial number, distinguishing the shipwrecked ones from those of, say, random drowning victims or forgetful beachgoers. (Ultimately, those serial numbers led Ebbesmeyer to deduce that only four of the five containers had likely opened—spilling 61,280 shoes into the sea.)

Ebbesmeyer visited the beachcombers repeatedly, and fit right in. "A kindred spirit—with a PhD!" thought McLeod. He was footloose, so Ebbesmeyer deputized him to document where more Nikes turned up. On the Oregon coast, McLeod met with a diner waitress who directed him to her brother-in-law, who had a garageful. In another town, he looked both ways, then dove head first into a Dumpster for Nikes discarded by a beach cleanup crew. Crossing over into British Columbia, he eventually reached the wild Queen Charlotte Islands, near Alaska. He joined a sea-kayaking trip in the southern islands and, farther north, met beachcombers who had recovered Nikes. Meanwhile, Ebbesmeyer collected more reports from his expanding beachcomber network. After a year or so, they had compiled reliable details on 1,600 wash ups, a 2.6 percent recovery rate—very respectable.

Ebbesmeyer's old buddy, Jim Ingraham of the U.S. National Oceanic and Atmospheric Administration, had worked for years to extrapolate a computer model of changing Pacific surface currents from Navy weather data, but so far it was only theoretical; here was a real-life test. They plugged in spill coordinates with beaching coordinates and dates; the predictions of Ingraham's Ocean Surface Current Simulator (OSCURS) matched nicely. This allowed Ingraham to refine OSCURS, and draw computer-animated Nike paths, spreading like ganglia in the ocean and balling up in coastal currents. Then, based on historical weather data, they simulated identical spills for May 27 of every year, 1946 to 1991. The Nikes went a different way each time—a tribute to the ocean's variability. "The surface layer is a strange place," said Ingraham.

Even before it was published in the geophysical journal *Eos*, the study made them minor media stars (what reporter could resist science based on oceangoing sneakers?), and with this, Ebbesmeyer found his true calling. Hundreds of people phoned to see if he could advise on other odd floatables they had found. Failing to find even one other scientist pursuing such things, he decided he was the man for the job. He had already cut his paid workweek 40 percent in order to write more; now he awaited his fondest hope: another big container spill. Besides McLeod, his occasional unpaid "research assistants" included Barry Tweed, a retired Oregon contractor who had built two stunning seaside houses of cedar, hemlock and redwood logs salvaged from surf; John Anderson, a Forks, Washington, plumber who had backpacked 30,000 drift-net floats from beaches to a very large pile by his garage; and Vern Krause, a Washington school bus driver with the distinction of having found a mysterious stainless-steel sphere that was confiscated by the military after Ebbesmeyer sought help in identifying it. (Deemed safe, it was returned the next week.)

In December 1991 a friend sent Ebbesmeyer a message in a bottle found on southern Vancouver Island. Gingerly

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prying open the dampened sheets, Ebbesmeyer saw Chinese characters—a printed appeal for the release of the famous dissident Wei Jingsheng, by then imprisoned 12 years. It took Ebbesmeyer and six colleagues a year of phone calls and help from a friendly American ex-intelligence man to, first, decipher the waterlogged message, and then establish that Taiwanese frogmen had been aiming propaganda bottles toward the mainland for years. Evidence suggested this one had likely been released in summer 1980 near the island of Quemoy, when coastal currents were favorable. Obviously, it had gone off course. Ingraham again applied OSCURS to plot the probable route—through an island chain below Japan, then across the Pacific—and they published a paper in *Eos*, ending with their hope that "the magic of bottle notes" would secure Wei's release from a second term in prison. In 1997 Wei was freed—though no bottle connection is known—and when he came through Seattle, he met with Ebbesmeyer, who gave him a copy of the *Eos* paper.

Anderson's haul also includes Japanese soda bottles, orange C ration containers and other finds.

In 1993 an article from the Sitka (Alaska) *Sentinel* metamorphosed into the team's proudest achievement. It reported that scores of tangerine-size yellow ducks, green frogs, blue turtles and red beavers had beached in Alaska coves. Another big container spill—bathtub toys, no less.

Ebbesmeyer confirmed some 400 sightings along 530 miles of Alaska shoreline. Deciding experiments were in order this time, he obtained samples from the toys' U.S. distributor, Kiddie Products. Each four-toy set was housed in a plastic shell with a cardboard backing, but soaking in seawater dissolved it, meaning the toys had probably been released to go their separate ways within 24 hours.

Ebbesmeyer also noted that some of the salvaged toys appeared to have been gnawed by sea otters, so he drilled otter-tooth-size holes in his samples to judge what portion of the originals might have sunk: none. "Very high-quality bathtub toys," said Ebbesmeyer. "Buoyant even when half-waterlogged." He stuck them in his freezer to see if Arctic cold would crack them. Nope.

Then one day he got a call from a minor shipping executive, telling him his ship had come in and directing him to a Tacoma dock. Ebbesmeyer spent four hours with the captain, who opened the ship's log to the spill—29,000 toys dumped on January 10, 1992, at 44.7 degrees north, 178.1 degrees east. With the picture complete, OSCURS got huge amounts of new data. Best of all, Kiddie Products printed the duckies' calculated twisty 15,000-mile route on the back of every new bathtub-toy package. "By far our best publication," says Ebbesmeyer.

He has since founded the nonprofit Beachcombers' and Oceanographers' International Association, complete with the *Beachcombers' Alert!* newsletter (500 paid subscribers from as far as West Africa and New Zealand) and its own Website (www.beachcombers.org). The organization has documented spills of everything from onions to hockey gloves.

Aiming to census marine trash in general, in summer 1999 Steve McLeod signed onto a small sailing vessel owned by the environmentalist Algalita Marine Research Foundation for three weeks. They headed into one eye of the North Pacific Subtropical Gyre—dubbed the Garbage Patch, because it collects so much junk. McLeod spent the three weeks seasick despite his years in the Coast Guard—but still scanning the horizon. About as far from land as one can get, they found piles of rope, fishing gear, liquid containers, a volleyball, even a refrigerator. The main haul was nurdles: drags with fine nets indicated 129,000 per square mile—six times the mass of collected zooplankton. A mahimahi caught for dinner was full of nurdles.

Ebbesmeyer felt sick when he heard the results. "How do we measure the sea's wildness?" he said. "Like a doctor sizing up a patient, I'd look her in the face. She's breaking out in a nasty rash."

Lately he can be found in his basement warren of six rooms crammed floor to ceiling with newspapers, books and blue loose-leaf binders marked by topic, all related somehow to floating things. I visited him there and saw he was continuing to expand: there were rare books on funerary practices of the ancient Vikings, who liked setting dead people adrift. One binder read CUBAN REFUGEE RAFTS. A recent subject of speculation, as reported in *Beachcombers' Alert!*: Did the shipwrecked Cuban boy Elián González survive because porpoises, supposedly attracted to the floatable inner tube, had nudged the boy to safety?

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Syncopal episodes have been reported in association with the use of ARICEPT®. ***Gastrointestinal Conditions:*** Through their primary action, cholinesterase inhibitors may be expected to increase gastric acid secretion due to increased cholinergic activity. Therefore, patients should be monitored closely for symptoms of active or occult gastrointestinal bleeding, especially those at increased risk for developing ulcers, e.g., those with a history of ulcer disease or those receiving concurrent nonsteroidal anti-inflammatory drugs (NSAIDS). Clinical studies of ARICEPT® have shown no increase, relative to placebo, in the incidence of either peptic ulcer disease or gastrointestinal bleeding. ARICEPT®, as a predictable consequence of its pharmacological properties, has been shown to produce diarrhea, nausea and vomiting. These effects, when they occur, appear more frequently with the 10 mg/day dose than with the 5 mg/day dose. In most cases, these effects have been mild and transient, sometimes lasting one to three weeks, and have resolved during continued use of ARICEPT®. ***Genitourinary:*** Although not observed in clinical trials of ARICEPT® cholinomimetics may cause bladder outflow obstruction. ***Neurological Conditions:*** Seizures: Cholinomimetics are believed to have some potential to cause generalized convulsions. However, seizure activity also may be a manifestation of Alzheimer's Disease. ***Pulmonary Conditions:*** Because of their cholinomimetic actions, cholinesterase inhibitors should be prescribed with care to patients with a history of asthma or obstructive pulmonary disease. **PRECAUTIONS Drug-Drug Interactions** ***Drugs Highly Bound to Plasma Proteins:*** Drug displacement studies have been performed *in vitro* between this highly bound drug (96%) and other drugs such as furosemide, digoxin, and warfarin. ARICEPT® at concentrations of 0.3-10 µg/mL did not affect the binding of furosemide (5 µg/mL), digoxin (2 ng/mL), and warfarin (3 µg/mL) to human albumin. Similarly, the binding of ARICEPT® to human albumin was not affected by furosemide, digoxin, and warfarin. ***Effect of ARICEPT® on the Metabolism of Other Drugs:*** No *in vivo* clinical trials have investigated the effect of ARICEPT® on the clearance of drugs metabolized by CYP 3A4 (e.g. cisapride, terfenadine) or by CYP 2D6 (e.g. imipramine). However, *in vitro* studies show a low rate of binding to these enzymes (mean K_i about 50-130 µM), that, given the therapeutic plasma concentrations of donepezil (164 nM), indicates little likelihood of interference. Whether ARICEPT® has any potential for enzyme induction is not known. ***Effect of Other Drugs on the Metabolism of ARICEPT®:*** Ketoconazole and quinidine, inhibitors of CYP450, 3A4 and 2D6, respectively, inhibit donepezil metabolism *in vitro*. Whether there is a clinical effect of these inhibitors is not known. Inducers of CYP 2D6 and CYP 3A4 (e.g., phenytoin, carbamazepine, dexamethasone, rifampin, and phenobarbital) could increase the rate of elimination of ARICEPT®. ***Use with Anticholinergics:*** Because of their mechanism of action, cholinesterase inhibitors have the potential to interfere with the activity of anticholinergic medications. ***Use with Cholinomimetics and Other Cholinesterase Inhibitors:*** A synergistic effect may be expected when cholinesterase inhibitors are given concurrently with succinylcholine, similar neuromuscular blocking agents or cholinergic agonists such as bethanechol. **Carcinogenesis, Mutagenesis, Impairment of Fertility** Carcinogenicity studies of donepezil have not been completed. Donepezil was not mutagenic in the Ames reverse mutation assay in bacteria. In the chromosome aberration test in cultures of Chinese hamster lung (CHL) cells, some clastogenic effects were observed. Donepezil was not clastogenic in the *in vivo* mouse micronucleus test. Donepezil had no effect on fertility in rats at doses up to 10 mg/kg/day (approximately 8 times the maximum recommended human dose on a mg/m² basis). **Pregnancy** ***Pregnancy Category C:*** Teratology studies conducted in pregnant rats at doses up to 16 mg/kg/day (approximately 13 times the maximum recommended human dose on a mg/m² basis) and in pregnant rabbits at doses up to 10 mg/kg/day (approximately 16 times the maximum recommended human dose on a mg/m² basis) did not disclose any evidence for a teratogenic potential of donepezil. However, in a study in which pregnant rats were given up to 10 mg/kg/day (approximately 8 times the maximum recommended human dose on a mg/m² basis) from day 17 of gestation through day 20 postpartum, there was a slight increase in still births and a slight decrease in pup survival through day 4 postpartum at this dose; the next lower dose tested was 3 mg/kg/day. There are no adequate or well-controlled studies in pregnant women. ARICEPT® should be used during pregnancy only if the potential benefit justifies the potential risk to the fetus. **Nursing Mothers** It is not known whether donepezil is excreted in human breast milk. ARICEPT® has no indication for use in nursing mothers. **Pediatric Use** There are no adequate and well-controlled trials to document the safety and efficacy of ARICEPT® in any illness occurring in children. **ADVERSE REACTIONS Adverse Events Leading to Discontinuation** The rates of discontinuation from controlled clinical trials of ARICEPT® due to adverse events for the ARICEPT® 5 mg/day treatment groups were comparable to those of placebo-treatment groups at approximately 5%. The rate of discontinuation of patients who received 7-day escalations from 5 mg/day to 10 mg/day, was higher at 13%. The most common adverse events leading to discontinuation, defined as those occurring in at least 2% of patients and at twice the incidence seen in placebo patients, are shown in Table 1.

Table 1. Most Frequent Adverse Events Leading to Withdrawal from Controlled Clinical Trials by Dose Group

Dose Group	Placebo	5 mg/day ARICEPT®	10 mg/day ARICEPT®
Patients Randomized	355	357	318
Event/% Discontinuing			
Nausea	1%	1%	3%
Diarrhea	0%	<1%	3%
Vomiting	<1%	1%	2%

Most Frequent Adverse Clinical Events Seen in Association with the Use of ARICEPT® The most common adverse events, defined as those occurring at a frequency of at least 5% in patients receiving 10 mg/day and twice the placebo rate, are largely predicted by ARICEPT®'s cholinomimetic effects. These include nausea, diarrhea, insomnia, vomiting, muscle cramp, fatigue and anorexia. These adverse events were often of mild intensity and transient, resolving during continued ARICEPT® treatment without the need for dose modification. There is evidence to suggest that the frequency of these common adverse events may be affected by the rate of titration. An open-label study was conducted with 269 patients who received placebo in the 15- and 30-week studies. These patients were titrated to a dose of 10 mg/day over a 6-week period. The rates of common adverse events were lower than those seen in patients titrated to 10 mg/day over one week in the controlled clinical trials and were comparable to those seen in patients on 5 mg/day. See Table 2 for a comparison of the most common adverse events following one and six week titration regimens.

Table 2. Comparison of Rates of Adverse Events in Patients Titrated to 10 mg/day Over 1 and 6 Weeks

	No titration		One-week titration	Six-week titration
Adverse Event	Placebo (n=315)	5 mg/day (n=311)	10 mg/day (n=315)	10 mg/day (n=269)
Nausea	6%	5%	19%	6%
Diarrhea	5%	5%	15%	9%
Insomnia	6%	6%	14%	6%
Fatigue	3%	4%	5%	3%
Vomiting	3%	3%	5%	5%
Muscle cramps	2%	6%	5%	3%
Anorexia	2%	3%	5%	3%

Adverse Events Reported in Controlled Trials The events cited reflect experience gained under closely monitored conditions of clinical trials in a highly selected patient population. In actual clinical practice or in other clinical trials, these frequency estimates may not apply, as the conditions of use, reporting behavior, and the kinds of patients treated may differ. Table 3 lists treatment emergent signs and symptoms that were reported in at least 2% of patients in placebo-controlled trials who received ARICEPT® and for which the rate of occurrence was greater for ARICEPT® assigned than placebo assigned patients. In general, adverse events occurred more frequently in female patients and with advancing age.

Table 3. Adverse Events Reported in Controlled Clinical Trials in at Least 2% of Patients Receiving ARICEPT® (donepezil HCl) and at a Higher Frequency than Placebo-treated Patients

Body System/Adverse Event	Placebo (n=355)	ARICEPT® (n=747)
Percent of Patients with any Adverse Event	72	74
Body as a Whole		
Headache	20	21
Pain, various locations	5	7
Accident	5	7
Fatigue	3	5
Cardiovascular System		
Syncope	1	2
Digestive System		
Nausea	7	11
Diarrhea	5	9
Vomiting	3	5
Anorexia	2	4
Hemic and Lymphatic System		
Ecchymosis	3	4
Metabolic and Nutritional System		
Weight Decrease	1	3
Musculoskeletal System		
Muscle Cramps	2	4
Arthritis	1	2
Nervous System		
Insomnia	7	9
Dizziness	6	8
Depression	<1	3
Abnormal Dreams	1	3
Somnolence	<1	2
Urogenital System		
Frequent Urination	1	2

Other Adverse Events Observed During Clinical Trials ARICEPT® has been administered to over 1700 individuals [illegible] 1000 patients have been treated for at least 6 months. Controlled and uncontrolled trials in the United States included [illegible] to 1214 days. Treatment emergent signs and symptoms that occurred during 3 controlled clinical trials and two open-label trials in the United States were recorded as adverse events by the clinical investigators using terminology of their own choosing. To provide an overall estimate of the proportion of individuals having similar types of events, the events were grouped into a smaller number of standardized categories using a modified COSTART dictionary and event frequencies were calculated across all studies. These categories are used in the listing below. The frequencies represent the proportion of 900 patients from these trials who experienced that event while receiving ARICEPT®. All adverse events occurring at least twice are included, except for those already listed in Tables 2 or 3, COSTART terms too general to be informative, or events less likely to be drug caused. Events are classified by body system and listed using the following definitions: *frequent adverse events* — those occurring in at least 1/100 patients; *infrequent adverse events* — those occurring in 1/100 to 1/1000 patients. These adverse events are not necessarily related to ARICEPT® treatment and in most cases were observed at a similar frequency in placebo-treated patients in the controlled studies. No important additional adverse events were seen in studies conducted outside the United States. **Body as a Whole:** *Frequent:* influenza, chest pain, toothache; *Infrequent:* fever, edema face, periorbital edema, hernia hiatal, abscess, cellulitis, chills, generalized coldness, head fullness, listlessness. **Cardiovascular System:** *Frequent:* hypertension, vasodilation, atrial fibrillation, hot flashes, hypotension; *Infrequent:* angina pectoris, postural hypotension, myocardial infarction, AV block (first degree), congestive heart failure, arteritis, bradycardia, peripheral vascular disease, supraventricular tachycardia, deep vein thrombosis. **Digestive System:** *Frequent:* fecal incontinence, gastrointestinal bleeding, bloating, epigastric pain; *Infrequent:* eructation, gingivitis, increased appetite, flatulence, periodontal abscess, cholelithiasis, diverticulitis, drooling, dry mouth, fever sore, gastritis, irritable colon, tongue edema, epigastric distress, gastroenteritis, increased transaminases, hemorrhoids, ileus, increased thirst, jaundice, melena, polydipsia, duodenal ulcer, stomach ulcer. **Endocrine System:** *Infrequent:* diabetes mellitus, goiter. **Hemic and Lymphatic System:** *Infrequent:* anemia, thrombocythemia, thrombocytopenia, eosinophilia, erythrocytopenia. **Metabolic and Nutritional Disorders:** *Frequent:* dehydration; *Infrequent:* gout, hypokalemia, increased creatine kinase, hyperglycemia, weight increase, increased lactate dehydrogenase. **Musculoskeletal System:** *Frequent:* bone fracture; *Infrequent:* muscle weakness, muscle fasciculation. **Nervous System:** *Frequent:* delusions, tremor, irritability, paresthesia, aggression, vertigo, ataxia, increased libido, restlessness, abnormal crying, nervousness, aphasia; *Infrequent:* cerebrovascular accident, intracranial hemorrhage, transient ischemic attack, emotional lability, neuralgia, coldness (localized), muscle spasm, dysphoria, gait abnormality, hypertonia, hypokinesia, neurodermatitis, numbness (localized), paranoia, dysarthria, dysphasia, hostility, decreased libido, melancholia, emotional withdrawal, nystagmus, pacing. **Respiratory System:** *Frequent:* dyspnea, sore throat, bronchitis; *Infrequent:* epistaxis, post nasal drip, pneumonia, hyperventilation, pulmonary congestion, wheezing, hypoxia, pharyngitis, pleurisy, pulmonary collapse, sleep apnea, snoring. **Skin and Appendages:** *Frequent:* pruritus, diaphoresis, urticaria; *Infrequent:* dermatitis, erythema, skin discoloration, hyperkeratosis, alopecia, fungal dermatitis, herpes zoster, hirsutism, skin striae, night sweats, skin ulcer. **Special Senses:** *Frequent:* cataract, eye irritation, vision blurred; *Infrequent:* dry eyes, glaucoma, earache, tinnitus, blepharitis, decreased hearing, retinal hemorrhage, otitis externa, otitis media, bad taste, conjunctival hemorrhage, ear buzzing, motion sickness, spots before eyes. **Urogenital System:** *Frequent:* urinary incontinence, nocturia; *Infrequent:* dysuria, hematuria, urinary urgency, metrorrhagia, cystitis, enuresis, prostate hypertrophy, pyelonephritis, inability to empty bladder, breast fibroadenosis, fibrocystic breast, mastitis, pyuria, renal failure, vaginitis. **Postintroduction Reports** Voluntary reports of adverse events temporally associated with ARICEPT® that have been received since market introduction that are not listed above, and that there is inadequate data to determine the causal relationship with the drug include the following: abdominal pain, agitation, cholecystitis, confusion, convulsions, hallucinations, heart block (all types), hemolytic anemia, hepatitis, hyponatremia, pancreatitis, and rash. **OVERDOSAGE Because strategies for the management of overdose are continually evolving, it is advisable to contact a Poison Control Center to determine the latest recommendations for the management of an overdose of any drug.** As in any case of overdose, general supportive measures should be utilized. Overdosage with cholinesterase inhibitors can result in cholinergic crisis characterized by severe nausea, vomiting, salivation, sweating, bradycardia, hypotension, respiratory depression, collapse and convulsions. Increasing muscle weakness is a possibility and may result in death if respiratory muscles are involved. Tertiary anticholinergics such as atropine may be used as an antidote for ARICEPT® overdosage. Intravenous atropine sulfate titrated to effect is recommended: an initial dose of 1.0 to 2.0 mg IV with subsequent doses based upon clinical response. Atypical responses in blood pressure and heart rate have been reported with other cholinomimetics when co-administered with quaternary anticholinergics such as glycopyrrolate. It is not known whether ARICEPT® and/or its metabolites can be removed by dialysis (hemodialysis, peritoneal dialysis, or hemofiltration). Dose-related signs of toxicity in animals included reduced spontaneous movement, prone position, staggering gait, lacrimation, clonic convulsions, depressed respiration, salivation, miosis, tremors, fasciculation and lower body surface temperature.

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One theory behind Elián González's survival, vivified in a mural installed in Miami, is that dolphins nosed the boy's inner tube, an appealing floatable, to safety.

Next day I visited John Anderson, the plumber with the major fishing-float collection. Anderson had obtained the superstructure of a large crane, planting it vertically in his front yard and covering much of its 40-foot height with foam fishing floats—a kind of totem pole. "My monument to beachcombing," he said. A four-hour tour through the grounds, house and outbuildings showcased his meticulously organized acres of doll heads, fish gaffs, hard hats with people's names on them, sake bottles, neoprene gloves, ropes, a police LSD-testing kit, fossils, animal bones. "Curt taught me not to overlook anything," said Anderson.

Down in Cannon Beach, McLeod seemed a little depressed. He showed me around town, sporting a pair of fancy Nikes—he has a lifetime supply—but a business plan to sell sculptures of beachcombed kelp stalks had tanked due to lack of demand. The beaches were spectacular—and covered with countless nurdles. Had they been gold flakes or garnets, we would have been rich. While we hiked, McLeod fantasized about new ways to make money, including a machine to filter recyclable nurdles from sand.

On my travels I also did a lot of beachcombing myself. My best site was the Willapa National Wildlife Refuge at Leadbetter Point, Washington. It was a mile-and-a-half walk through dense bush and drizzle to a long, arcing beach where a receding tide, trackless sand and tsunamis of sanderlings flying just above the swash told me I was on a still-wild coast. There are so few left.

Here, in addition to countless plastic bags, bottle tops, and soda and water bottles, I logged 302 items. Partial list: beer cans—Coors, Bud, Miller, Hamm's, Rainier; plastic Kodiak chewing tobacco tin; blue plastic 55-gallon drum, empty; blue plastic hospital ID bracelet, no name; peppermint Life Saver, individually wrapped; glass Oso Negro liquor bottle, top on; two foam fishing buoys; plastic deli clamshell; three car tires; Taco Bell bag; synthetic rope; 12 spent shotgun shells; intact fluorescent light tube; plastic containers for Windex, Spic & Span, Pennzoil, Dannon and Yami yogurts, Darigold cottage cheese, L'Oreal Kids shampoo; a sneaker made in Taiwan; red-billed cotton cap; two nice scallop shells; a golf-ball-size chunk of light gray pumice, possibly from Mount Saint Helens; and—beginner's luck—a real live message in a bottle.

It was a semitransparent white plastic vitamin bottle with a rusted metal cap, half buried in fresh, wet sand, displaying a paper square jammed inside. I unscrewed it and pulled out two dry sheets—a photocopied memorandum dated Oct. 20, 1999, regarding lifeboats aboard the USS *Camden*. There was an informal Q&A regarding life, and its alternative, after abandoning ship for the boats.

Q: After you are in the water, what is the most likely cause of injury to be encountered?

A: Underwater explosion.

Q: How do you enter the water and proceed away from the ship in case of burning petroleum in the water?

A: Enter feet first, swim under water, coming to the surface for air by splashing water away from your head on the way up, go under again and swim under the water, repeating the process until you are clear of the flame.

Q: With water, how long could a man survive without food?

A: Three weeks or longer.

Q: How long could a man survive without water?

A: Eight to twelve days.

And so on.

I checked with the Navy. The *Camden* is a combat-support ship, based near Seattle. Most of its recent missions had been routine coastal exercises. As far as I could tell, all aboard were safe and well; I do not know why someone dropped this bottle, which probably did not drift far. I now keep it in a cabinet by my desk. For some reason, more than anything else I have, it reminds me of the sea.

Kevin Krajick's Barren Lands: A Journey to the North American Arctic in Search of Diamonds *will be published this fall by W.H. Freeman. Photographer Rick Rickman is based in Laguna, California.*

RICK WILKING/REUTERS

Melton joins manikins he's clothed in dress uniforms from the Soviet NKVD and the East German Stasi.

FOR YOUR EYES ONLY

KEITH MELTON'S MUSEUM CONTAINS THE FINEST COLLECTION OF ESPIONAGE PARAPHERNALIA ANYWHERE—AND IT'S SO SECRET WE CAN'T EVEN TELL YOU WHERE IT'S LOCATED

KEITH MELTON RECEIVED THE TELEPHONE CALL ON A TUESDAY AFTERNOON. By Thursday evening he stepped off a plane in Munich, eyes peeled for the "go-between." He'd been instructed that his contact would carry a newspaper in his left hand and a pipe in his right. Melton spotted a stout, middle-aged man in rumpled clothing who fit the description. The man spoke no English.

Melton was ushered into a waiting car, and they drove for two hours into the rural Bavarian countryside in silence before pulling off into a deserted parking lot where another vehicle waited. Headlights flashed, and the other car pulled up. Melton and the two others assembled behind the other car. He held his breath as the trunk was unlocked. Inside was a small suitcase-size machine in perfect condition. Melton's heart raced—he'd chased this espionage coup for years, biding his time and making countless discreet in-

BY HANK SCHLESINGER ◆ PHOTOGRAPHS BY THEO WESTENBERGER

MELTON TUCKED THE ESPIONAGE RARITY IN THE OVERHEAD BAGGAGE COMPARTMENT.

quiries. Finally, he had it in his hands, a machine of such secrecy and importance that it had changed the course of world events.

It was a scene right out of le Carré. But Melton was not a spy, and the Enigma machine played its role more than five decades ago. H. Keith Melton is the world's premier historian and collector of tradecraft—the procedures, techniques and devices used in clandestine intelligence operations. This would not be the first time that Melton had gone to such considerable trouble to obtain an object for his collection. What he acquired that evening was one of the rarest cipher machines in the world, an electromechanical device that looks like a turbocharged manual typewriter. During World War II, the Enigma became a key element of the German war effort, enabling fast and secure communications. The Allies ultimately needed the help of a British team led by Alan Turing, who designed the world's first electronic computer, to crack the complex Enigma cipher, which relied on a series of changeable rotors and settings. When it was broken, the Allies eavesdropped on thousands of encrypted German military communications and were able as well to monitor their own counterintelligence efforts. Busting the Enigma cipher proved a decisive factor in the Allied war victory. For one thing, the Allies learned the location of German U-boats, and that helped win the Battle of the Atlantic. The breaking of the Enigma remained so secret that it didn't become public knowledge until the early 1970s.

Despite the language barrier between Melton and his contacts, negotiations for the device proceeded smoothly, with each side writing numbers down on a piece of paper. By the next evening, Melton flew home with the espionage rarity tucked away in the overhead baggage compartment. That Melton owns not one but two of the very few Enigmas in private hands is not surprising. He has amassed the finest private collection of espionage paraphernalia in the world. Not even government-operated exhibits or museums can match the scope of Melton's collection. Russia's internal security service—FSB—boasts a museum in Moscow, though its exhibits, as Melton explains, focus primarily on that organization's history up to 1945 and counterintelligence successes during the Cold War. While the CIA Museum at the agency's Langley, Virginia, headquarters has an exhibition on intelligence history and a growing collection of artifacts, it borrowed more than 500 items from Melton when it created a display of tradecraft for its 50th anniversary in 1997.

When Melton started collecting 30 years ago, there was no facility in which espionage artifacts were studied and archived. "I felt," explains Melton, "that these items would not only be lost but the stories of the incredible people who developed them and used them would never be told, because of the necessary requirements of secrecy." In his southern Florida museum, he displays more than 2,000 artifacts from his 7,000-piece collection. He also owns some 6,500 books and 30,000 photographs. The Spy Museum has become a magnet for members and former members of intelligence services from around the world, including the CIA and the KGB. It's not open to the public, so Melton prefers to keep its exact location, well, secret. Outside its nondescript entrance, a birdhouse conceals an all-weather video surveillance camera.

To step from Florida's pastel landscape with its bright sun and palm trees through the museum's door is to enter another world. The first-floor libraries, furnished in dark woods, oriental carpets and floor-to-ceiling bookcases, are more reminiscent of an Edwardian-era men's club than a repository for high-tech gadgetry. Melton climbs a narrow staircase and flicks on a set of lights, revealing fifty-six 4- by 8-foot display cases. Arranged inside them are the artifacts that were once some of the most closely guarded secrets of nations from around the world.

What catches my eye immediately is a large, oblong metal object, nearly 13 feet long and shaped like a large sea kayak. It is a one-man submarine, known as a Motorized Submersible Canoe. Built by the British Special Operations Executive (SOE) during World War II, this craft was designed to carry a wet-suited saboteur into an enemy harbor either fully or partially submerged. The operative could "park" the electrically powered sub on the bottom, then swim to shore for his mission. Of the 100 manufactured, only 3 exist today. It's hard to imagine climbing into this boat, much less going underwater into an enemy port at night. When I learn its history, the sub's moniker, "Sleeping Beauty," seems more ominous than whimsical. British operatives attempted to use Sleeping Beauties in a 1944 mission into Singapore's harbor, but the saboteurs were discovered and killed. Two other missions in Nor-

P. 50, P. 53 AND P. 56 H. KEITH MELTON COLLECTION, FROM *THE ULTIMATE SPY BOOK*

The Steineck ABC wristwatch camera (opposite) was used by U.S. Air Force intelligence officers in the 1950s. The World War II tool kit of a Norwegian SOE radio operator (above) includes a saboteur's fountain pen, which conceals igniters for detonating explosives.

way and France involving this odd craft remain classified.

Melton points to the air cylinders contained in the submersible canoe's midsection, revealing a surprise: the cylinders are stamped unmistakably with a German *Luftwaffe* eagle. Melton explains that during the war, Britain didn't have the manufacturing capacity to produce non-iron, alloy air cylinders, an important requirement when the magnetic compass rested right above the cylinders. Eventually, they hit on the idea of scavenging the nonferrous air tanks from German Heinkle bombers shot down over Britain. Wartime necessity creates strange bedfellows.

Melton acquired this Sleeping Beauty from a man who found it in a veterans' hall in upstate New York. After negotiating a price, he loaded it on a trailer and drove off. It's all part of a day's work for Melton, who is soft-spoken and given to clarifying points with thoughtful precision. He studied engineering at the U.S. Naval Academy and served as an officer in Vietnam. A successful entrepreneur in the food service business, as well as a co-owner of a television production company, Melton is also a professor at the Centre for Counterintelligence and Security Studies in Alexandria, Virginia, and a guest lecturer at intelligence ser

A desktop of duplicity: The eyeglass case, cigarette lighter and pack conceal cameras; the ashtray, globe and phone serve as listening devices; the papers are forged or altered; the other items are concealment devices. Inside the Stasi pen (opposite) lies a microdot viewer.

vices, and has written four popular books about espionage.

No formal market exists for espionage artifacts, so he's had to build a network of contacts over decades. He's made countless trips to Western Europe, Russia and former Soviet Republics. The items have come from scholars, retired intelligence personnel and shady characters. Melton's museum is apolitical by design. If judgments are made, they are aimed at technology and procedure, not ideology. "If I'm meeting in Berlin with a former member of the MfS—the East German secret police, or Stasi," explains Melton, "I tell him we will discuss the effectiveness of Stasi espionage techniques, not Cold War politics." He's never sure where his next artifact will show up or what he'll have to do to get it. His second Enigma machine turned up in a garage in New Jersey. He smuggled one small item out of the Soviet Union in his cheek. I find him reluctant to speak about the provenance of some pieces because revealing details could compromise sources and expose methods that he has carefully developed for years.

Although the museum opened its doors—very selectively—in 1998, it's been nearly three decades in the making. "The first step," remembers Melton, "was not to gather

"JAMES BOND IN THE REAL WORLD OF ESPIONAGE WOULDN'T SURVIVE FOUR MINUTES."

equipment but to learn about the business of espionage." Immediately, Melton encountered a problem: If something is really secret, how do you know what it looks like or where to find it? Melton proceeded by building a library of documents, books and images. In this way, he began to define the function of intelligence and how technology supported those functions. "To know what spy equipment looks like, it's critical to understand what spies do," says Melton.

Everyone understands what spies do, right? Wrong, says Melton. Consider James Bond, most people's idea of a spy. "James Bond was a figment of Ian Fleming's imagination," says Melton. "James Bond in the real world of espionage wouldn't survive four minutes." He'd be extremely ineffective for one thing. Bond's goals, Melton suggests, appear to be seduction and assassination, not recruiting moles and gathering intelligence information. Whether from the Russian SVR, the CIA or the British MI6, intelligence officers are most often scholarly individuals who are comfortable chatting up unwitting sources at a bar or socializing over dinner, beginning friendships that may lead to acquiring information. "Intelligence ends when you pick up a gun," Melton adds, quoting a retired KGB officer. "Spies don't kill spies." It's more cloak than dagger.

As a result, Melton's museum has few guns but several hundred examples of "dead drops." If spying is all about the transfer of information, then communication between spy and handler is the most dangerous time for a spy. Intelligence services worldwide developed dead drops or "dead letter boxes," as they are called in Europe. "Dead drops are a way of separating the spy and the handler, by time but not space," he explains.

Melton's collection includes hundreds of examples, such as a stone and bolt that contain hollowed out centers. While dead drops may appear to be an anachronism of the Cold War, they remain in use today. Robert Hanssen, one of the FBI's senior counterintelligence experts, who was recently arrested for spying for Moscow over the past 15 years, used the 14-acre Foxstone Park near his Vienna, Virginia, home for his dead drops. Hanssen dropped highly classified documents and computer disks wrapped in garbage bags underneath a wooden footbridge. His Russian handlers completed the transaction with similarly wrapped bags of cash.

In the espionage business, objects used to hide top secret documents within a home or when crossing borders, known as concealment devices, are lessons in cleverness. Melton's collection includes a World War I-era glass eye, brown with painstakingly painted blood vessels. Behind the concave piece of glass, one imagines, is just enough room to conceal a tiny roster of spy names. A seemingly mundane soap container from a toiletry kit, on loan to the CIA from Melton's collection, offers an ingenious, tamper-proof feature: unless the container is first placed on a magnet to deactivate a hidden switch, opening the container will trigger a flashbulb that will expose the film contained inside.

Melton leads me to a sturdy-looking candlestick. It's matte black and stands ten inches tall, entirely unremarkable in every visible detail. And that, says Melton, is exactly the point. "This is probably the most intricate concealment I've ever seen," he says. A quick examination reveals no point of entry to the secret cavity he says is located in the base. A battery is necessary to open it. The spy applies voltage at two different points, inserting a positively charged needle three-quarters of an inch into a particular spot in the felt base. The current trips an electro-servo motor inside, which permits the bottom to be removed. The cavity is large enough to contain a small Minox camera, several rolls of film and perhaps a spare passport. The KGB issued this candlestick for use during the 1970s or '80s.

While dead drops and concealment devices remain a staple of the spy trade, it was a development of a different sort during World War II that would alter the espionage landscape overnight. The portable and concealable radio would change tradecraft forever by enabling spies for the first time to send information back to headquarters instantly from the field. Melton strolls over to the other side of the room to a display that holds a small portion of his large collection of World War II-era spy radios. While some appear barely able to fit in the overhead bin of an aircraft, they were considered tiny by standards of their day. Prior to the war, radio stations filled entire rooms. Melton believes that it was largely the work of a 24-year-old signals officer in the British Army named John Brown that changed all that. Brown developed the so-called suitcase radio in 1942. The Type B Mk II fits in a large black valise and weighs 32 pounds.

WORLD WAR II PROVED A TURNING POINT IN THE HISTORY OF ESPIONAGE TRADECRAFT.

The Mk II found service in the employ of the SOE, a group of British operatives who worked behind German lines in occupied Europe, committing acts of sabotage, gathering intelligence and coordinating the efforts of resistance groups. By 1943 the ingenious Brown had managed to lighten the suit case radio by nearly 20 pounds with the invention of the Type A Mk III.

Radios were not the only reason that World War II proved a turning point in the history of tradecraft. It was, says Melton, the first global intelligence war. Intelligence services needed not just one or two spy radios but a thousand, to supply their agents all over the world. To support the production of intelligence-gathering equipment, the government looked to the private sector. For example, when the United States Office of Strategic Services (OSS) was unable to find enough Minox cameras, they asked Kodak to produce Camera-X, America's first professional spy camera. It was so small that field operatives could disguise it with local matchbox covers (SMITHSONIAN, October 1987).

Across from the displays of radio and high-tech wizardry, I stop at a case that contains a copper mesh bra. "This," says my guide, "belongs to one of history's most famous—and inept—spies." A photograph reveals the buxom figure of Mata Hari, the World War I-era courtesan, dancer and legendary seductress, who tried unsuccessfully to spy both for Germany and France.

Mata Hari's risqué top counts as one of the few pieces in Melton's collection that predates World War II. Seventy percent of the objects originate from the Cold War and 25 percent from World War II. Only 5 percent of the items date earlier. Few pre-World War II espionage artifacts exist because there was no mass production of tradecraft items back then. For this and other reasons, the golden age of tradecraft was the Cold War.

The winners of this war would prevail not on the open battlefield but in the darkness of back alleys, where the advantage lay not in sheer force of arms but in the cleverness of clandestine operations. In the parlance of the espionage industry, this warfare became known as signals intelligence, or Sigint, which referred to all manner of eavesdropping and covert communication. Innovations advanced at a breakneck speed and provided new twists on time-honored themes.

On July 4, 1945, just two months after the German forces surrendered, a group of Soviet Young Pioneers presented U.S. Ambassador W. Averell Harriman in Moscow with what appeared to be a thoughtful gift. Melton leads me to a case holding a facsimile of the present, a Great Seal of the United States, an exquisitely carved light wood disk about the size of a large pizza platter. Unknown to Harriman, this gift contained a passive cavity resonator, a half-dollar-size metal object attached to a brass rod, which was embedded directly behind the bald eagle. The genius of this device lies in the fact that it required neither electrical power nor wiring. Sound from the Ambassador's office passed through a small hole beneath the eagle's beak and hit the resonator, which acted like a large ear. Soviet technicians could listen to conversations in the room by bouncing radio waves off the resonator's antenna rod from a remote listening station.

What the Soviets learned from this ingenious device remains classified. Suffice it to say, the seal was operational during a tense period when the Allies redrew the map of Europe, the Soviets instituted a blockade of West Berlin and the United States began the airlift. When American operatives finally discovered the presence of the bug in the seal seven years later, they had no idea how it worked and dubbed it the Thing. It took a technical wizard at the British internal security organization, MI5, to figure it out. By then, however, the Russians had developed passive eavesdropping technology even further.

Soviet scientists had dis covered that buildings act as

America's romance with the spy was reflected in the popularity of espionage board games between the 1930s and 1970s.

Melton spoofs the spy profession by posing in a trench coat and sunglasses, an outfit never worn by a real-life intelligence agent.

natural resonators. Specifically, they studied the phenomenon that the human voice causes slight vibrations in windowpanes. By reflecting infrared waves off window glass at a precise point, the Soviets learned that they could hear conversations within a room. This was at a time when the American concept of eavesdropping was taking a headset from Western Electric and crossing it across a pair of telephone wires.

If the United Kingdom and the United States were horrified by the advanced technology employed by the Thing, they were also quite impressed. Within a short time both nations fielded similar devices; the British calling their version the Satyr. Melton pauses by an architectural model of a rather ordinary-looking office building. It represents the KGB residence inside the Soviet trade mission in London. Clearly visible in the cutaway are vibro-acoustic sensors clipped to the iron bars embedded in reinforced concrete, or rebar, comprising the building's load-bearing columns. "When these sensors are attached to rebar in a concrete column," says Melton, "they turn the entire column into a giant omnidirectional microphone." The British placed them in columns in the Soviet trade mission. The Russians discovered them and used the technology years later in the new American Embassy in

Moscow. And so the furious cat-and-mouse game continued throughout the Cold War.

As I walk from case to case, I'm confronted with a virtual who's who of spies. In one display is the samovar, pen, camera and drinking flask of Britain's Kim Philby, one of the most successful spies of the 20th century. On a visit to Moscow, Philby's widow presented Melton with his suit jacket.

There is also a Nordstrom tailor-made suit and other memorabilia from the notorious Aldrich Ames, who caused the deaths of at least ten CIA agents and revealed countless secrets to the Soviets as chief of the Soviet Division of the CIA's Counterintelligence Section. Melton's collection includes a section of the ceiling from CIA headquarters that was used as a platform to surveil him. Small holes indicate where the camera and microphone would have been mounted. Another case displays electronic artifacts from the American spy John Walker, the KGB's most important agent during the Cold War. I've been aching to find out from Melton who he thinks was America's most notorious spy.

Melton doesn't take long to answer when I finally pose the question. He picks the FBI's Robert Hanssen, whose recent escapades have filled the pages of national newspapers. If the charges against him are proven, Melton believes he will go down as the most damaging spy in our history, especially to the FBI and national security apparatus. Melton seems particularly impressed with his tradecraft skill. "I think Hanssen will be remembered as one of the most effective spies ever uncovered." Hanssen may be the only spy who managed to establish his bona fides while keeping his identity secret from his handlers. A recent photography expedition by Melton to Hanssen's sites confirm the skill with which he had chosen his alleged dead drops. The park close to his home provided him not so much with convenience but a logical reason for being in the area.

Melton switches off the lights in this room of secrets, and we descend the museum stairs, back to the library. The future of espionage, according to Melton, will be shaped by the Internet and the power of high-speed computers. Using methods of steganography—hiding messages within seemingly harmless documents or graphics—it's possible to embed intelligence messages on common Websites. If a dead drop separates the spy and his handler by time, not space, then the Internet promises to distance the two parties by time *and* physical space with the sharing of only cyberspace.

Predictably, this kind of espionage is less fascinating to Melton. "A silicon chip can contain the most incredible encryption algorithm in the world, but it's removed from people and of less interest to me." He's far more intrigued with the technology and devices that take advantage of human creativity and ingenuity but are also limited by human frailties. Even though digital encryption technologies grow more advanced and increasingly difficult to crack, intelligence organizations will still need to resort to old-fashioned cloak-and-dagger techniques.

One last question remains for me to ask Melton, who knows more about tradecraft than perhaps anyone else. Has he ever been surprised? Melton answers with a story. When a revered Sovietologist passed away several years ago, he left Melton several artifacts, including a number of items from his service in the OSS and CIA and items belonging to Alexander Orlov, who before fleeing to the United States was the Soviet handler for Kim Philby and other members of the infamous Cambridge Spy Ring. As Melton was on his way out to the car, the Sovietologist's son turned to him and said, "Dad left you one last thing."

Melton motions to a small curio cabinet mounted on a pedestal. Inside, wrapped in plain paper, are Alexander Orlov's ashes. "He's our resident master spy."

SPY MUSEUMS NOT UNDERCOVER

Top secret clearance won't be necessary to visit the following organizations devoted to tradecraft: the International Spy Museum (www.spymuseum.org) opens next spring in Washington, D.C.; the Smithsonian-affiliated Cold War Museum (www.coldwar.org), although yet to find a permanent site, offers half-day spy tours to espionage hot spots in Washington (703-273-2381); the National Cryptologic Museum (www.nsa.gov/museum, 301-688-5849) in Fort Meade, Maryland, is dedicated to the history of American cipher and code craft; the Allied Museum in Berlin contains many artifacts from the Cold War, including a guardhouse from the Checkpoint Charlie border (www.alliiertenmuseum.de/).

Driven into the ground at a dead drop, this spike could conceal a 35mm roll of film.

Freelance journalist and author Hank Schlesinger writes from New York City. Photographer Theo Westenberger enjoyed playing spy for the day.

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CHEZ CHANEL

SHE NEVER MADE SKETCHES, RARELY drew a line. She reigned over Parisian high fashion most of the 20th century—and her designing spirit is yet with us. Down on her knees she would tug hard at a pieced-together muslin, the rough semblance of a Chanel original. "To get the fit right, she'd jab you with a pin," Suzy Parker, one of Coco Chanel's favorite models, told me. Only the fabric, cut on the bias, mattered. "Stand straight, girl," Chanel would hiss through a mouth full of pins. "If there's no woman, there's no dress."

All her life, Chanel combined her skills as a seamstress—her only training, as an orphaned child—with her shrewd sense for inspiring and promoting daring but seductive leaps in style. Her first flourish was in millinery, selling smart, trim Parisian hats she designed and wore herself, and her real debut—at the fashionable seaside resort of Deauville in 1913—came from restyling an old knit "nothing" by snipping it with a pair of scissors.

"I cut the front of an old jersey so I wouldn't have to pull it over my head," she told author Paul Morand in 1960, explaining her fashion coup. Then she quickly added a ribbon, a collar and a knot to produce a Chanel original. "People asked me, 'Where did you find that dress?' I said, 'If you like it, I'll sell it to you.' 'How much?' I said I will have to find out. I sold ten dresses like that. My dear, my fortune is built on that old jersey that I'd put on because it was cold in Deauville."

Couturiere and courtesan, Coco made her own rules as she freed women from old fussy, frilly fashions

She had invented sports clothes—only, as she remarked, for "watching sports"—tailored out of common jersey knits. Knits had been barely acceptable as underwear, but she had herself photographed on the beach in her newly cut cardigan, with pushed-up sleeves and too-big pockets, and made jersey, even in gray and navy, suddenly chic.

Her fashions were always boldly and bodily liberating. She early convinced her aristocratic clientele—then smart women everywhere—that naturalness through casual dress emphasized the feminine, that no woman need artificially strive to heighten her charms. Over her lifetime, from her first rejection of the belle epoque's feathers and flamboyance to her ultimate simplicity (how she loved a long rope of pearls!), she set the trend, especially for American women who flocked to Europe.

Gabrielle Chanel has been gone for three decades, dying at the age of 87, and until the end, still insisting on going to work. But her influence survives even in today's trash-chic Paris fashion scene. At Chanel, Karl Lagerfeld is in charge.

Lagerfeld has done a box-office business with Chanel accessories—like the famous pocketbook with its

BY BROCK BROWER

Top: Ubiquitous cigarette dangling, Chanel repins the armhole of one of her famous "little black dresses" while a model apprehensively holds still. Above: The model of simplicity herself, Chanel steps back to study a softly flounced chiffon evening dress from her August 1957 collection. In the mid-1950s, Coco sought a balance between her prewar styles and current fashion that struck a responsive chord with American women.

interlocked, back-to-back double C's catch, and the perfume Coco. But his glitz always draws its substance from echoes of past Chanel grandeur.

At one recent show, Lagerfeld gave each model a touch, a flounce of gauze or feathers, like a puff. These are the same ruffles you see in a famous photograph of Coco Chanel at 50, at her wrist, while around her neck a soft white collar sets off her sculpted features, severe but gamine, and Gallically dark. She had "two long black eyebrows," her friend the author Colette once wrote of the younger Chanel, "that she doesn't pluck, despotic, ready to shoot up, to be lowered, quivering . . . under the black vault of her hair."

The best place to recapture her forceful presence is in her apartment, on the third floor at 31 Rue Cambon, in Paris. You climb up the Art Deco curved, mirrored staircase, round a corner of beige-carpeted steps where Chanel used to sit back out of sight to watch her clients at showings of her own collections, catching their reactions reflected in the facings and facets of the mirrors.

The rooms are elegant, black and gold, again with beige carpets, crowded with many objets d'art and some *d'amour*. Christine Menkin, the Chanel archivist, is direct about the passionate side of Mademoiselle's life. "Chanel never married," she states. "She was a courtesan." It is said in tribute. These rooms are where she held court, entertained, granted interviews, though she always slept across the street at the Hotel Ritz.

The dominant furnishings are her coromandel screens, treasures of Chinese art, inlaid with delicately painted vignettes of Oriental life. She acquired her first screens in 1912 with Arthur "Boy" Capel, her English lover, with whom she had just run off from her French lover Etienne Balsan.

Chanel had already traveled far by

DOUGLAS KIRKLAND/CORBIS; BETTMAN/CORBIS; P. 61 AGENCE FRANCE-PRESS

the time she joined Balsan at his château, Royallieu. Behind lay her destitute past—born out of wedlock in a poorhouse hospice in the garrison town of Saumur, her mother dead after five children by the time Chanel was 12. Her feckless father deserted his children, and Gabrielle spent the next six years in an orphanage, being taught—mainly to sew—by the nuns. Refusing to acknowledge the orphanage, she always referred vaguely to "aunts," but those were nuns who got Gabrielle—as a charity case at Notre Dame School—to the next big town of Moulins.

She got her nickname at Moulins' café La Rotonde, perhaps responding to a dare from the rakish cavalrymen of the Tenth Light Horse regiment who came to applaud or jeer the young women trying out their voices during the café show's intermission.

Gabrielle Chanel stood up and sang a heartstrings dirge about a girl who lost her dog, Coco, at the Tracadéro. "Oh Coco, / Who has seen Coco?" Her voice was weak, but as always she put herself into it totally. According to another version of the story, it was when she tried to sing out a rooster's cry—cocorico! And the Light Horse yelled back, "Coco! Coco!" In any case, her spunk came through, and eventually cavalryman and cavalier Etienne Balsan asked "Coco" if she'd like to see how he trained racehorses at Royallieu.

There, the petite Coco turned herself into an accomplished horsewoman. Her equestrian advice to other women: "A woman must imagine herself with a pair of balls."

Boy Capel joined them for the foxhunt at Pau in the Pyrenees, and joshed Balsan about neglecting the girl. When Boy departed, so did Coco—without even a suitcase, to catch him at the Pau train station. When he saw her, "He opened his arms."

Gallant bargaining ensued over what Coco herself baldly called "my hot little body." Balsan, willing to live and let live, said she's yours, my dear fellow, and repeated an earlier offer to let her sell her hats out of his Paris apartment. "But that's all," he insisted. Chanel set up her hat shop at his apartment at 160 Boulevard Malesherbes. She eschewed elaborate plumes and fussy trimming to create her wide-brimmed straws, and soon had an eager clientele, as fascinated by her as by her wares.

Capel was a rich playboy, but also a shrewd manager of his Newcastle coal interests. He secretly provided credit backing for her move to a mezzanine at 21 Rue Cambon. He helped found the House of Chanel because he saw Coco had a good head for business and just enough genius and sheer energy to succeed.

"I'm here to make a fortune. Henceforth, nobody spends a centime without my permission."

She was furious when she found out he was covering her overdrafts. The next day she told an assistant, "I'm here to make a fortune. Henceforth, nobody spends a centime without my permission." And steadily she rose in the estimation of Paris, expanding into 31 Rue Cambon, soon climbing above illegitimacy and shedding the mantle of tradeswoman.

Then, of course, Boy Capel left her to marry the daughter of a lord. Also, of course, he missed Coco, and soon was spending time with her at a St. Cloud hideaway in 1919. When he died that December in a fiery automobile accident, Chanel fell into an abiding grief for the great love of her life. Boy left a fortune of £700,000 (about $21 million in 1990s currency) chiefly to his wife and child, but £40,000 went to "Gabrielle Chanel of Quai de Tokio, Paris."

But truly, what was the need? She was doing splendidly on her own, having pioneered a thinner, uncorseted look during those years of World War I. "I let go of the waistline and came up with a new silhouette," she later explained. "To get into it, and with the war's connivance, all my clients lost weight, to 'become skinny like Coco.'" She was now getting 7,000 francs per dress ($2,100 in 1990s terms), in Biarritz, Deauville and Paris, and she had a staff of 300.

Here in America, *Harper's Bazaar* ran the first picture ever of her couture, "Chanel's charming chemise dress." No collar, no bodice, but a deep V-necked, near-masculine waistcoat, no puffs, no frills, with a large hat with a twist of fur. She was stealing an early march on the flapper look of the upcoming '20s.

But her artistry went well beyond her boutique. Chanel had been pursuing the Paris art world since 1913, when her own summer triumph came on the heels of Russian ballet immortal Vaslav Nijinsky's wild dancing at the Ballets Russes' premiere of Igor Stravinsky's *Rite of Spring*. By 1924, she was costuming Ballets Russes dancers with shocking new bathing suits—"very daring," said one of the dancers. She put the lead ballerina into a pink maillot with a skullcap, which soon became fashionable headwear. Two years later, she did the Greco-modern costumes for Jean Cocteau's *Orphée*, mixing the mythical and *la mode*, and her smart country outfits for Orpheus and Eurydice started another trend, this one for informal dress.

All this rested upon an elaborate network of acquaintances. When, in 1921, Sergei Diaghilev was struggling to revive *Rite of Spring*, Chanel visited

the harried Ballets Russes director, who needed £1,000 to open. He had just dunned the Princess Edmond de Polignac, the Singer sewing machine heiress, for 75,000 francs. "She's a grand American lady," said Chanel. "I'm only a French couturiere; here's two hundred thousand." She also quietly subsidized Igor Stravinsky, having already taken him as a lover. Her dance card was crowded with proud but impecunious poets, and proud but distressed Russian émigré nobility. Writer and filmmaker Jean Cocteau had a cocaine habit, and over and over she paid for his drug cures. Then, in 1923, on Christmas holiday in Monte Carlo, she was invited to dine with Hugh Richard Arthur Grosvenor, the duke of Westminster, one of the richest men in England, aboard his yacht, *The Flying Cloud*. Chanel and Westminster were together, more or less, for the next decade.

By 1924 Coco was marketing the fashion product that would make her imperial: Chanel No. 5. She collaborated with a well-known "nose," as perfumers are known—Ernest Beaux, who wanted to experiment with new artificial scents beyond the flowery range of the usual rosewater.

Chanel didn't want lilies of the valley either. "On a woman, a *natural* flower scent smells *artificial*." They would reverse the paradox, and start with an artificial scent—benzyl acetate, a coal tar derivative that smelled like jasmine. Beaux explained that benzyl acetate, combined with real jasmine extract, kept the scent from fading. At first skeptical, Beaux soon had great respect for Chanel's own marvelous nose.

Among seven or eight final samples, she picked his fifth essence. L'Eau Chanel would be "redolent, evocative of woman," she decided. "A woman's perfume." Because of the jasmine, it would be expensive, Beaux warned. Put in more jasmine, demanded Chanel. "I want to make it the world's most expensive perfume." She had the fitting rooms sprayed at 31 Rue Cambon and handed out small vials to her best clients.

She had already designed the squared, almost pharmaceutical bottle—her break with every past fussy flacon—and had brazenly chosen her own name, plus the Beaux sample's Number 5, said to be her lucky number. But Beaux's laboratory couldn't produce in quantity, so she had to make a deal with the brothers Pierre and Paul Wertheimer, owners of France's largest fragrance company, who could manufacture enough perfume to meet the heavy demand.

Put in more jasmine, demanded Chanel. "I want to make it the world's most expensive perfume."

To avoid any chance of losing control of the House of Chanel, she reluctantly settled for 10 percent of the profits from the independently capitalized Les Parfums Chanel, controlled by the Wertheimers. That deal brought her a fortune, but for the rest of her life Chanel sued—through her lawyer, René de Chambrun—for the riches she believed the Wertheimers had stolen from her helpless, orphaned, improvident self.

A year later came her first rendering of the classic Chanel suit. It had a cardigan jacket, like her very first jersey dress, trimmed with braid, but no collar, and long, tightly fitted sleeves. She set the armholes high so that she could sculpt a clean, close look. With its always graceful skirt, that 1925 Chanel suit is still being copied today, as is her "little black dress," introduced in 1926, that ultrafeminine statement of serviceable cocktail wear, another stunning innovation in a world accustomed to black for mourning. But she was also moving out more boldly, taking fashion cues from the crew of Westminster's *Flying Cloud*. She adapted sailor's caps and shirts and crewneck sweaters to a new line of sportswear, and finally, even sailor's bell-bottom trousers. Why shouldn't she be as comfortable climbing aboard ship as any other tar? And so, when Coco appeared on the Venice Lido in pants, she started yet another trend.

But now well into her 40s, she found herself in an untenable bind with Westminster. She could never really bring herself to exchange the House of Chanel for his Eaton Hall, and she was tired of his petty flings. On one occasion when a pretty young decorator hastily disembarked from *The Flying Cloud*, the duke also went ashore. He returned with a magnificent string of pearls for Coco. Serge Lifar, a Ballets Russes dancer, described what happened.

"When the duke offered her the necklace, which was worth a fortune, Coco, in a gesture of superb defiance, let the pearls slide from her hand into the ocean."

She had the strength of will, and by now the money, to do it.

But, as the depression of the '30s slowly paralyzed, then divided, European society, the House of Chanel began to languish. Chanel had set the tone for high society, but on the slim base of her special clientele, who were accustomed to ordering up the Chanel gown, damn the expense.

Such clients were fewer, and unrest was growing among the "hands" who did the stitching. Chanel was notoriously miserly with her hands, who in the 1930s numbered 3,000. And as for raises for her models—"They are gorgeous girls, why don't they find lovers?" she complained.

A Chanel retrospective, clockwise from above: A velvet evening dress, 1935; a black silk taffeta gown, 1937; beige lace over gold, 1954; an apricot chiffon evening dress, 1957; a dress of speckled, braid-trimmed wool, 1957; a plaid wool suit, 1965; a two-piece wool jersey dress, 1954; and a 1955 summer outfit.

CLOCKWISE FROM TOP LEFT: BETTMANN/CORBIS; BETTMANN/CORBIS; BETTMANN/CORBIS; BETTMANN/CORBIS; BETTMANN/CORBIS; AGENCE FRANCE PRESSE/BETTMANN/CORBIS

At her London salon in 1932 (top) Chanel sits with a group of models. Standing at her left is Lady Pamela Smith, one of several socially prominent Englishwomen who showed Chanel creations. Chanel went to England originally in 1924 at the invitation of her friend, Hugh Richard Arthur Grosvenor, the duke of Westminster. Above: In a signature suit and pearls, Coco makes a point in a dressing room of her Paris fashion house.

One Sunday in June 1936, she walked out the back of the Ritz to find Rue Cambon crowded with her workers, taking part in a general strike. They had occupied the House of Chanel. Chanel settled in time for the fall-winter collections, but never forgave such "madness."

Diana Vreeland, the longtime editor of *Vogue*, remembered a gypsy gaiety to Chanel's '30s fashions, but these gypsies were whistling in the dark, perhaps to keep up courage against the threat of another war. Three weeks after Nazi Germany invaded Poland in September 1939, starting World War II, Coco abruptly let everybody go, and shut down the House of Chanel.

The irony is that closing her doors became, as her biographer Axel Madsen notes, "Chanel's treason." First her workers, then the government, tried to force her to reopen—for la belle France, just as in the earlier world war. She bridled at such naïveté, but she hadn't counted on the worst. Turned against France, Hitler's blitzkrieg overran half of the country and the other half became a collaborationist mockery. A dozen Paris houses did collections in 1941 for black marketeers, and the wives and mistresses of German officers. Chanel stayed closed, but, "I was wrong," she recalled bitterly. "They never stopped selling fashion during the war."

All her chic friends adjusted, with smooth loathing, to the war. The Wertheimers fled, but kept control of Les Parfums Chanel, selling Chanel No. 5 throughout the Reich and, without her knowledge, in the United States. Chanel lived, with German permission, at the Ritz.

Impulsively, she took up with a tall, blond German officer, much younger than herself, who spoke fluent French—Hans Gunther von Dincklage, nicknamed Spatz. A former diplomat, Spatz was always in

civilian clothes, like as not an *Abwehr* counterespionage officer. Which means a spy, though how much of a spy, or even for which side, is unclear, since he mostly investigated the best wine cellars. "He isn't German," Coco claimed. "His mother was English."

After Paris was liberated in 1944, Chanel was taken for three hours of questioning by the Free French about Spatz, long gone, but was released. Why did she never face charges of collaboration? Was her old friend Winston Churchill, who had met her through Westminster, her protector?

Within weeks of peace, Pierre Wertheimer turned up again. He was effusive. They had set up a new corporation, Chanel, Inc., through Wall Street, had put all the money they could get their hands on into a new factory in Hoboken, New Jersey, and had gone worldwide with a reconstituted Chanel No. 5. Her royalties had been deposited in Zurich. They turned out to be all of $15,000. Even in today's value, barely $60,000.

"I want revenge," she cried, but attorney René de Chambrun said not yet, bide your time.

She began a wandering exile, going from Lausanne—where she saw Spatz again—back to Paris, then on to her country house at Roquebrune, until she arrived at the inspiration that would be both her salvation and the perfect revenge.

At age 71, she would reopen the House of Chanel.

She sold the country house. She sold off unneeded space adjoining 31 Rue Cambon and moved back into her apartments. Then she got an offer from Carmel Snow, editor of *Harper's Bazaar*, to help put her in touch with American ready-to-wear. That forced the Wertheimers to take an interest, and Pierre agreed to pay for half the costs of her first new collection.

It was shown on February 5, 1954—the hottest ticket in Paris, biographer Axel Madsen wrote. And then, as the *London Daily Express* gloated, "A Fiasco—Audience Gasped!" She was roundly jeered for returning to her styles of yore, reaching as far back as 1930, even 1925. Karl Lagerfeld, just 17, a student at the Chambre Syndicale design school, from Hamburg, was there. Later, he remembered how sad and creaky and "prehistoric" the salon parade was, but he also "loved this look that harked back to a prewar world I hadn't known." Its "intoxicating" effect convinced him Chanel had struck "the right compromise" between her style and the '50s look.

Three weeks after Hitler invaded Poland, Coco let everybody go, and shut down Chez Chanel.

From her hidden step perch, staring into the disaster reflected in her staircase mirrors, Chanel set her wide jaw. Women were too smart to stay away, she declared, despite this razzing. Already she was getting signs of support, especially from America. Three weeks after the show, over four pages, *Life* saluted Chanel's "easy-fitting suits" that didn't have "the 'poured-on' look."

"American women had already been liberated," explains model Suzy Parker. "They'd been to work during the war. European women hadn't."

Then Bettina Ballard, editor of French *Vogue*, put a Chanel navy-blue jersey suit on the March cover. And even more delicious, the Wertheimers could no longer afford not to keep helping her. The éclat of the fragrances they sold in her square flasks depended upon the reputation of Coco Chanel. And Chanel No. 5 had been slipping toward the demotic status of *l'eau de toilette*. That May, on Pierre's initiative, they bought her out. From then on, "We paid everything—the Ritz, her secretaries, servants, everything including her telephone bills and postage stamps."

And Chanel went on to a gradual, undeniable triumph. My wife, then Ann Montgomery, and a *Vogue* model working at the House of Chanel, remembers the sharp intake of breath all around her when "Mademoiselle Ann" walked gracefully down the runway in the bouclé suit Chanel had crafted for her—on her—from the rough muslins. That was May of 1955, during what Coco called her "demi-collection," to upstage her competitors, largely males of despised talent. The audience gave a burst of applause, surprising to my wife, but for Coco a joy remembered.

Chanel Couture was still a black hole for the Wertheimers, but by the '60s, her commonsense designs had reclaimed the fashion silhouette for freedom and femininity, especially with the Chanel suit. Suzy Parker modeled its trim jacket and slim skirt often. "It's sort of British military," she says, in the sartorial style of several of Coco's lovers. "You can swing your arms without the jacket riding up your back. Then you're free to move, raise an arm, hail a taxi. You're in street clothes."

The Chanel suit was also just right for expensive copy or licensed ready-to-wear. Once, Chanel's patterns were routinely bid out to the sharpest bargainers in the rag trade, but now Chanel Couture has boutique outlets in London, New York, Los Angeles, and elsewhere throughout America, particularly Dallas, where Neiman-Marcus' flagship store has long served as the Texas bypass for Rue Cambon. This has its touch of tragedy when you recall the pink suit that Jackie Kennedy was wearing the day the President was shot riding through

Dealey Plaza. It was a Chanel copy.

Coco died in 1971 at the Ritz. But she is best remembered in the Rue Cambon apartment, on her vast gold couch, where she would tuck up into its cushions, so very small, like "a tiny, little bird." Still with her flair for independence and elegance, watching over her fashion legacy: that trim, vibrant, chic, so turned-out, feminine silhouette. Around her, the scenic intimacy of those coromandel screens, all exactly positioned, with an exit cleverly cut into the back wall so that Mademoiselle never had to see a door open or shut in these rooms. Never had to watch anybody depart, leaving her behind, alone.

Coco left a complicated estate of $90 million (in 1990s currency), while the Wertheimers have surely done, in the dark maze of French finance, better by half. Much of this wealth came through the Chanel-logoed accessories, like the handbag, but those, too, were legitimately a Chanel passion. She was the first to create costume jewelry that mixed paste stones with true gems, and actually got Etienne de Beaumont, who had never had a job in his life, to design necklaces, brooches and other paraphernalia for her. That is exactly the touch of grand luxe, spread expensively en masse, that Lagerfeld has managed so nimbly since he took over design for Chanel Couture in the '80s.

At the 2001 spring show, both Lagerfeld and Yves St. Laurent created fashion-world astonishment with a remarkably similar white blouse over a black skirt, reminiscent of Chanel's early simplicity. Later, Lagerfeld was asked if, by parading his Chanel clothes on a runway that resembled a curving seaside boardwalk, he was taking fashion back to Deauville?

"It never left," he said.

Brock Brower profiled Scottish poet Robert Burns in the March 2001 SMITHSONIAN.

Coco Chanel strides down the street to the House of Chanel, on Paris' Rue Cambon, in 1968, three years before her death at 87. She worked to the end, driven as always to succeed.

NEW YORK TIMES PICTURES

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FOLLOWING THE TRACK OF THE CAT

THE BUSHMEN OF NAMIBIA ARE SO GOOD AT READING THE LANGUAGE OF FOOTPRINTS THEY CAN TELL WHAT A LEOPARD DID THE DAY BEFORE THEY STARTED PURSUING IT

BY RICHARD CONNIFF ◆ PHOTOGRAPHS BY JIM LEACHMAN

WE FOUND THE LEOPARD AFTER DARK. SHE WAS lying in the grass when the spotlight revealed her profile. Her massive shoulder muscles bulked out like a Janus face at the back of her neck. She got up and walked toward our vehicle and looked straight up at us as she slinked past, bathed blood-red by the filter on our light.

The guide recognized her as the daughter of a female he routinely followed. She was 2 years old, and the big, lumbering Land Rovers of the nearby lodge were as natural to her as elephants. She began to hunt, with three vehicles idling 50 yards behind her, through a thin forest of mopani trees. When the slink shifted unmistakably to a stalk, all the engines shut down and the lights went out. There was no moon, just starlight. A small herd of impalas stood off to the right, barely visible through binoculars. No one knew where the leopard was. It was an eerie moment, the guides whispering, everyone waiting for something to die.

Suddenly, a commotion broke out on the right. The spotlight blinked on and caught the spectacle of the leopard up a tree leaping from one branch to another

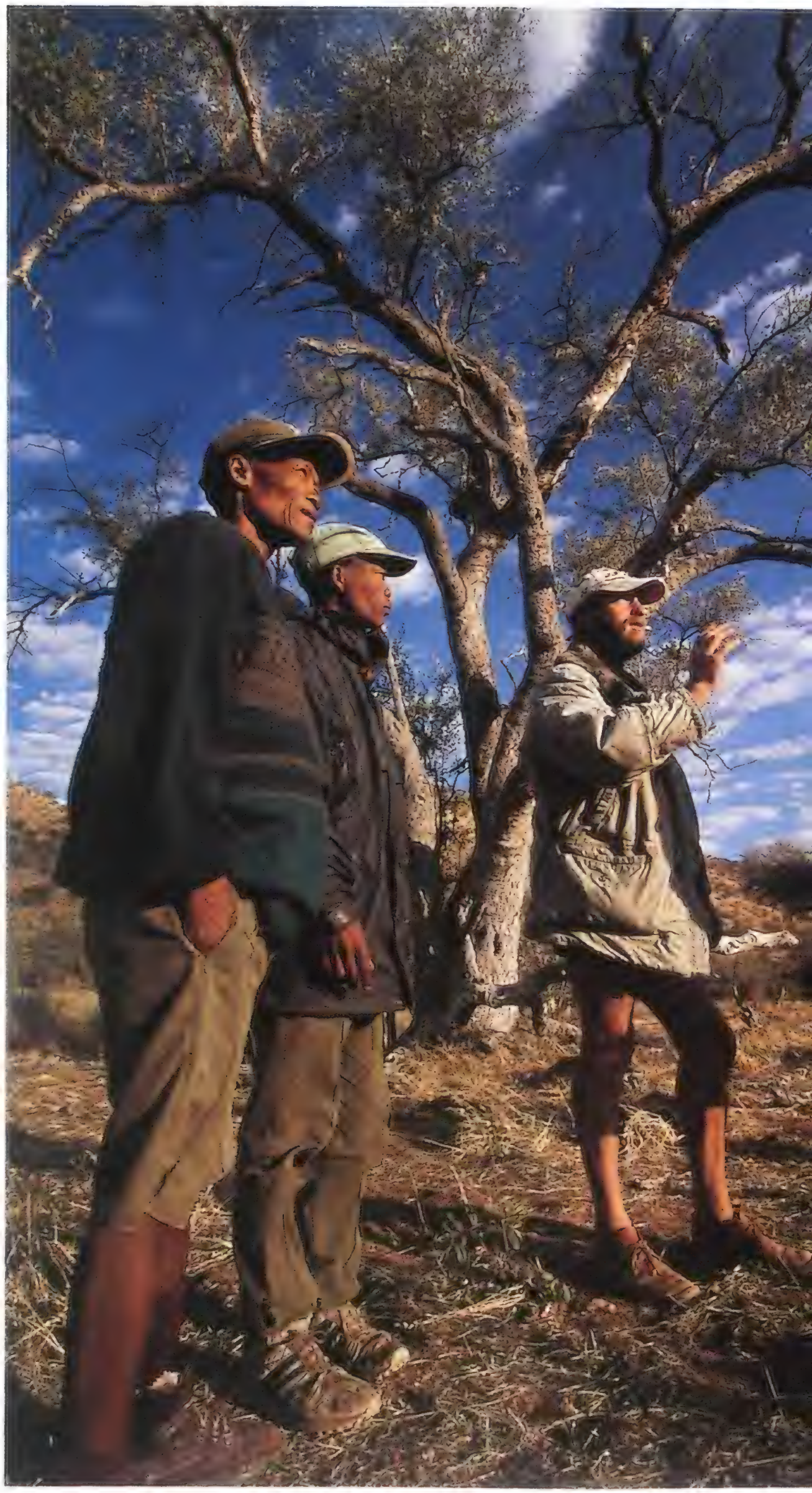
Subtle clues in a print (left) may tell trackers how long ago a leopard crouched before climbing a tree to rest (opposite).

as four or five barn owls screamed "Chee-chee-ee" and tumbled away in a panic of flashing white underwings. The impalas barked in alarm, a sound like a short, wet sneeze. A couple of terrified baboons yelled "Wah! Wah!" And every human in earshot exhaled.

Fear of leopards is entirely natural. We have an old and tangled relationship: our ancestors were living among leopards and sometimes being killed by them before we were even human. One archaeologist, noting that leopards frequently stash an impala or other prey up a tree, has argued that early hominids scavenged for food by raiding the leopard's larder. Leopards returned the favor. At the Transvaal Museum in Pretoria, South Africa, for instance, there's a 2-million-year-old hominid skull with puncture marks in the forehead precisely the breadth of a leopard's bite.

Our relationship is, if anything, even more tangled today. Leopards live like phantoms not just in deserts and jungles but even within the limits of major cities. Not long ago, biologists trapped ten leopards in a single park on the outskirts of the city of Dar es Salaam, capital of Tanzania. In Nairobi, Kenya, population three million, I recently visited a prison compound where a leopard had slipped in and plucked a guard dog off its chain. By stealth and wit, leopards have managed, alone among big cats, to thrive in modern Africa. They are invisible, and they are everywhere.

AT A REMOTE AIRSTRIP IN THE ARID pink hills of Namibia, on Africa's southwestern edge, I watched one day as a Cessna 206 touched down and rolled slowly to a stop. Two Bushmen trackers climbed out. They were slight, mild men with small ears and prominent rounded cheekbones. Their hair was bunched in tight little naps. Each of them carried a sashlike hunting bag



From left: Txoma, Tkui and biologist Flip Stander ponder the best place to locate a leopard trap. They have already wired a bloody hunk of bait in the tree directly behind them.

made from steenbok skin, worn soft with heavy use. Each bag contained a small bow strung with sinew, and a quiver made from PVC pipe.

The pilot, a Namibian leopard biologist named Flip Stander, introduced them to me. This was a chore. The Ju/Hoan language of the San, as the Bushmen are formally known, uses four distinct clicks, beginning at the front teeth and moving toward the back of the throat, for which English has no equivalent in spelling or pronunciation. Tkui (pronounced with a dental click, like tht-Kooey) was the younger of the two, about 35, and sharper-eyed. Txoma (pronounced with a mid-palate click, like tkk-Tcoma) was about ten years older, slower and more judicious. As trackers, they were fluent not just in the Ju/Hoan language of clicks and murmurs but also in the very subtle and more ancient language of footprints.

We spent the next few days driving through the dry, hilly countryside in Stander's 17-year-old truck, with Tkui sitting on a plank above the left headlight to scan the dusty road for footprints. We drove in second gear, at 10 or 12 miles an hour, and mostly saw the usual litter of antelope tracks. Then Tkui held up his hand, and we got out to examine some leopard prints. They belonged to a female we'd seen the day before.

"How can you tell?" I asked.

Tkui looked at me. "Can't you see?" he said.

Stander, who was translating, tried to explain. "It's a bit like seeing people walking on the horizon and you know that one's your wife. But could you say how? It's the way she walks, but how would you describe it?"

I contemplated the inscrutable indentations in the sand and pressed him to be a bit more specific. "When asked, they'll say it's a variation in the pads. But it's also a variation in the way of walking." I made him ask anyway, and Tkui tapped his right knee, then gestured with the closed knuckle of his hand as if taking steps. "The angle of it," Stander explained. The leopard's right hind foot is splayed slightly outward.

"The most difficult thing about tracking is individual identification," Stander told me. "There's nothing else that requires so much skill and intelligence." He once tested a team of four San trackers for a biological study and found they could identify individual animals (including humans) by their footprints 93.8 percent of the time. Once, when he was living out in the bush, Stander said, some canned food disappeared from his hut. The local women took one look at the footprints and named a teenager, who, on being tracked down some 20 miles away, admitted his guilt as if they had him by his DNA.

This habit of reading the world through the language of footprints is deeply ingrained. One night, an African wildcat stole some meat Tkui and Txoma had stored in a tree. The next morning, as if it were the most logical thing in the world, the two men followed the trail to the cat's lair and took the meat back. Txoma later told me that when a toddler becomes bored, his elders set him to following the trail of an ant. Tracking is simply what the San do.

Stander, barefoot as usual, dribbles a trail of the foul-smelling "stew" to attract cats to the trap. Oblivious to the stench, Txoma hauls a bucketful of the gore.

Stander, who is 38, earned his biology degrees at Cornell and Cambridge universities. But much of his higher education has taken place over the past ten years learning to track with the San. In the city of Windhoek, where he works as the official advocate for leopards, lions and other large carnivores with Namibia's Ministry of Environment and Tourism, he dresses like a trim, bearded park service bureaucrat. But in the field he wore a

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grimy down jacket, held together with blood stains and duct tape, and a pair of shorts, which revealed that he had scribbled field notes up both legs from knee to cuff. (A bad habit, he said, picked up trying to fly a plane and record sightings at the same time.) He went barefoot everywhere, even on slopes of sharp talus. When he needed to climb a tree, which was often, he grabbed a couple of branches and then walked with almost prehensile feet up the vertical bark.

The tree-climbing was essential for wiring up hunks of springbok and gemsbok as leopard bait. It was grisly work. The blood and guts got set aside to be added to a barrel of gore that had been maturing for more than a year and eight months under a tree back at camp. The trackers used it, ladled out with an old soda can wired to a stick, to make scent trails to lure leopards to bait trees and traps. "It becomes like a perfume," said Stander, both hands fanning the stench up to his connoisseur's nostrils. "The animals don't walk past it. They always stop right there."

The point of all this work was to determine how many leopards were living on a 71,000-acre ranch called Hobatere Lodge and radio-collar them for long-term study. With the trackers, Stander had taken the conventional hunting trick of identifying footprints in the roadbed and turned it into a mathematical technique for estimating the number of leopards per 100 square kilometers (38.61 square miles) of countryside. The trackers could also determine with amazing precision—98 percent accuracy in Stander's study—what each leopard had been doing the night before.

One day, Tkui headed out into the bush, with Txoma walking roughly parallel to him on the road, in pursuit of a big male leopard. "If we're lucky, we'll get it," said Stander. "It's heading straight for the bait."

The trail crossed rough ground, and the two trackers walked thoughtfully, eyes down, hands folded behind their backs. Sometimes they shared a length of copper pipe stuffed with tobacco, too hot for lesser mortals to handle, an upgrade from the traditional pipe made from a steenbok femur. They lost the trail for a time, and fanned out like hounds casting for a scent. Then Tkui whistled and swept his arm to indicate the way ahead, up a dusty riverbed. They crossed the trail of two leopards coming the other way, a mother and her cub perhaps. Stander and the two trackers circled around the trail and traded ideas. The back-and-forth had a slow, cumulative quality, which Stander later described as "trance-like." He broke away reluctantly and said, "This is the male track coming over. So the two leopards are probably from the night before."

"How can you tell the age of the prints?" I asked.

"By the way the wind has eroded them," he said, "and by the superimposed footprints of ants, mice, stuff that moves around."

We followed the deep prints of the male off through the mopani scrub. "The leopard's just gotten the scent," Tkui told us. He could see it in the sharpness of the toe prints. After a few feet more, Tkui crouched, sphinx-like, and peered ahead, mimicking the leopard. The cat had dropped onto its belly, and its forelegs had left long parallel lines in the sand, with the matching lines of the rear legs just behind. "He's looking."

Even I could see the evidence of stalking now, in the way each hind foot had been drawn up slowly and placed almost on top of the forefoot. Then the trail vanished again, and reappeared not at the bait tree but over in the shadow of a hill. The shift made the trackers think the leopard had crossed this way at first light: "When it's pitch dark, a leopard moves in the open. When it's lighter, he favors darker sides, shadowy bits." We crossed the scabby blood stains in the sand, and Tkui touched his nose to indicate the scent trail. But the leopard had walked right past, intending perhaps to wait out the day in some shady spot on the hill. We

Using a traditional bow, Txoma prepares to sedate a trapped leopard with a tranquilizer dart on the end of an arrow. He waits for a clear shot at the lunging cat's flanks.

Stander carries the groggy female to his truck, where he'll weigh her, take blood and hair samples, and put on a radio collar that henceforth will signal her whereabouts.

followed the trail up into a ravine, winding among the rocks and scrubby vegetation, and finally Txoma said, "We'll leave him now." They had the patience of hunters. The bait trees and box traps, cages with trapdoors, would do their work.

One day, we caught a female leopard, which hissed and lunged at us in her cage. With his bow, Txoma shot an arrow tipped with a syringeful of sedative into her flanks. When the leopard went down, Stander pulled her from the cage, wrapped his arms around her chest and lifted her off the ground. The leopard raised her head and looked around with dull, puzzled eyes. Her tongue lolled out endlessly, curled round and licked her nose. She stayed in this state of twilight waking while Stander weighed her and took blood and hair samples. Then he peeled back her lips to measure her canines with a caliper. (The uppers were both about 27 millimeters long, which translates, in U.S. standard measurement, to really big.) "Is she waking up?" someone asked. "Yeah," Stander replied. He put a radio collar on her and carried her back to the cage to recover overnight.

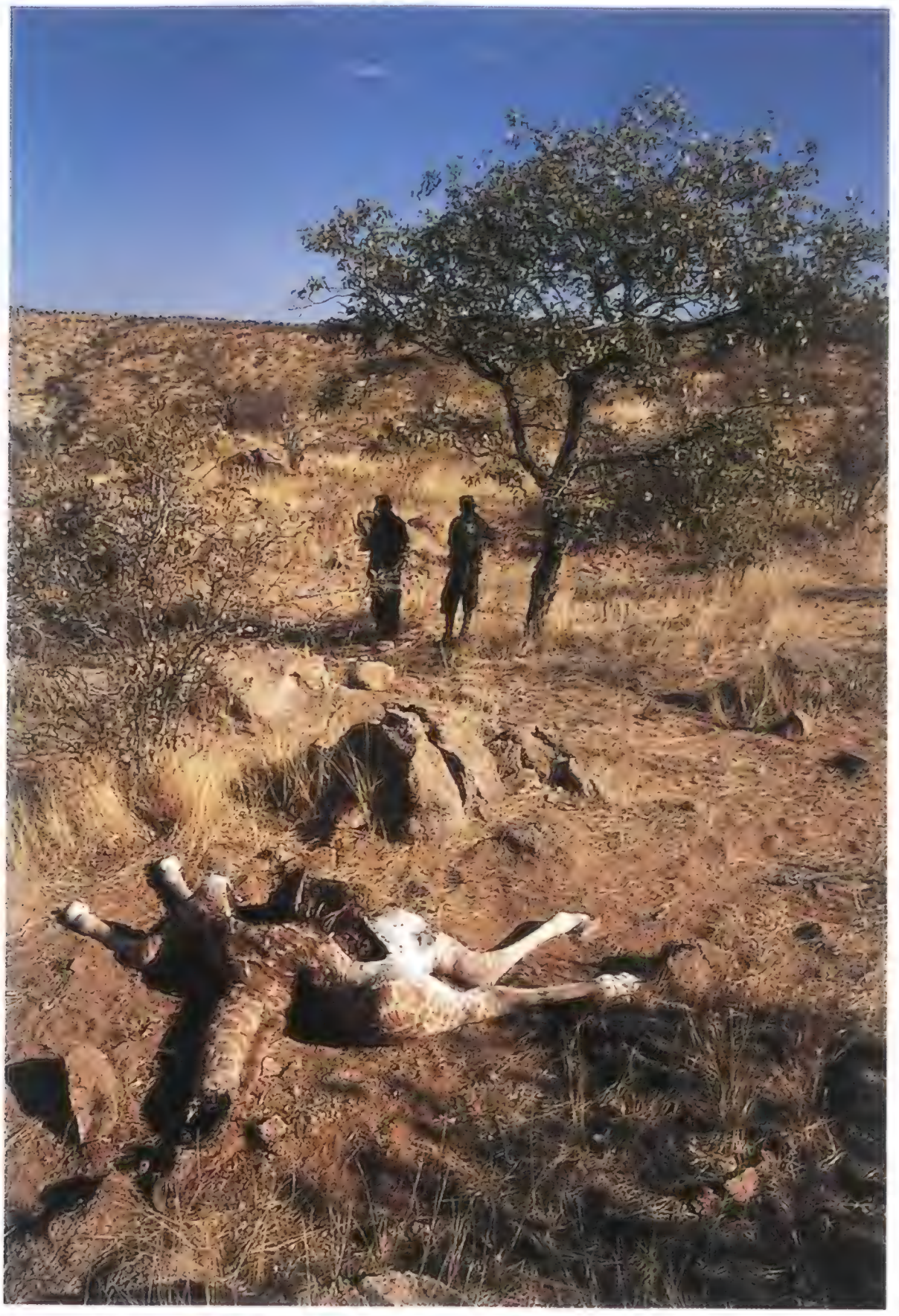
The trackers had already identified 13 different leopards along this unpromising 12-mile stretch of road, and it reminded Stander of the estimate by scientists at the World Conservation Union (formerly called the International Union for Conservation of Nature) that perhaps 300,000 leopards survive in sub-Saharan Africa. (In the Middle East, Russia and much of Asia, on the other hand, leopards are doing poorly; India, with an estimated 7,000 leopards, is their biggest stronghold outside Africa.) The population naturally varies with habitat. In the rain forest, a male leopard might get by in a home range of only about 50 square miles; in the Kalahari Desert, he might need around 1,300. Either way, the average person could practically step on a leopard and never know it.

"On 1,200 occasions," said Stander, "we've walked right up to a leopard. We knew it was there because of the radio collar. And in those 1,200 times, we actually saw leopards only twice. They just move off. We hear the signals all around us." One time, Stander was flying low, radio-tracking from an ultralight. "I saw the leopard directly below me under a bush, and I told the trackers where it was. Six trackers walking straight toward the leopard. I was getting scared because they were so close. These guys were about 50 feet away. This was flat country, no rocks, just scrubby vegetation. And the leopard just slinked down on its belly, it just snaked around them, and it was on their trail. They never saw it."

Leopards generally run away from humans. Tkui and Txoma counted on it so completely, they said one day as we sat around a campfire, that they sometimes followed fresh tracks to steal a leopard's kill. The desert was harsh, and hunting was always uncertain. So it wasn't, as the archaeologist had suggested, just early hominids who scavenged for a living at

the leopard's expense. "If we can see the possibility of food, we follow," said Tkui, who was busy frying bread cakes in oil.

Leopards are, after all, better hunters. For instance, the steenbok, a small, generally solitary antelope, is extraordinarily vigilant against predators. A gifted San hunter can approach undetected, "if everything is perfect," no closer than about 60 feet, said Stander. A leopard, on the other hand, can often get as close as 3 feet. It doesn't need to get that close, since it can pounce 20 feet in the air, "but the moment you pounce, the animal hears you and it's off. So the closer you can get the better." Once it kills an animal, the leopard will typically stash it up a tree and return three or four nights in a row to feed. It will often wait out the day nearby. So the idea of walking up and stealing the kill in broad daylight sounded risky. But the leopard, said Txoma, "always just runs."



Near the remains of a baby giraffe, Txoma and Tkui reconstruct the killing. They learn how a leopard patiently stalked the sleeping youngster by studying the ground.

Or almost always. Txoma told a story about a neighbor named Tollie, who depended on a pack of hunting dogs because he was deaf. One day, while Tollie busied himself at a pond, his dogs ran around to the other side, where they cornered a leopard in the bush and launched a horrific brawl. Tollie, hearing nothing, wandered over into the middle of it. The leopard promptly leaped up and bit him on the face and sank its claws into his shoulder. But as he started to fall, Tollie drove his spear into the leopard's chest and killed it. Then he stood up, "bleeding like a pig," and walked six miles to a village for help. Stander's team of trackers happened at that moment to be radio-tracking the leopard, which was one of their main study animals.

"So here we are tracking," said Stander, "and we find this leopard lying with a spear through his chest. The San looked around and said, 'These are Tollie's tracks,' and they reconstructed the whole thing. By the time the village people got to us, we knew exactly what had happened."

Stander had been hoping to walk me through such a reconstruction at the site of a recent kill, and that afternoon we hiked up onto a ridge where a leopard had been hanging out. Stander had gotten a glimpse of the radio-collared animal that morning from his airplane.

The ridge was dismal for tracking, all granite pavement and pebbles. But Tkui quickly found footprints. "When the plane went over, the leop-

A leopard stands guard near an antelope it has stashed in a tree. Though they are nearly everywhere in modern Africa, the stealthy cats are hardly ever seen.

ANUP AND MANOJ SHAH/ANIMALS ANIMALS

ard went this way," he said. "She was running." He showed me the depth of the rear prints, and the way the claws had scooped them out in back. Then he pointed to a print where the foot had clearly pivoted in place. "It's stopping here and looking at the plane," he said.

They lost the trail for a while, then separated and wandered ahead to where they thought they might pick it up again. "Tracking is so fundamental in hunting that it must have been extremely important in shaping how our minds work," Stander was saying. "Those who tracked best got more food. There must have been tremendous selection pressure. Watching these guys work, that makes so much sense. What they're doing here is a lot like science. You form a hypothesis about where the animal might have gone, and then you modify the hypothesis."

The two trackers meandered down the length of the ridge, weaving back and forth, sorting out several days' worth of leopard and hyena tracks, the circumstantial evidence of a recent kill. Finally, after about a mile, Tkui stopped, lifted his arm and pointed. A baby giraffe, perhaps 1 month old, lay with its legs splayed, its head twisted to one side, flies circling its open belly, and a paling of broken ribs sticking up on one side.

The two trackers studied the terrain. They traded thoughts on the significance of assorted inscrutable indentations. After they'd reached a consensus, Tkui walked us through the killing. It was three nights ago. The giraffe was lying on top of the ridge sleeping. Right here. The leopard was coming up the slope. Over here. Then it caught the scent. Tkui pointed out the pause in the footprints, and the signs of stalking. "The stopping may have been a half-hour, and the stalking may have been a long time too," Stander translated. "We have no way of knowing." Tkui reenacted the scene, crouching and slowly drawing his feet up between his hands until, after a distance of 80 feet, he came to a spot where there were two deep divots in the soil. It was just 16 feet from the sleeping giraffe. Tkui pawed the earth, digging in like a sprinter on the starting blocks. Then he pounced.

"The leopard landed on its back feet," he said, "and the front feet hit the animal here." He showed us the claw marks on the giraffe's left flank. The leopard lunged for its victim's throat. "As it grabbed on, the giraffe turned away." He then showed us the sweeping, circling marks in the sand. "There was this big struggle. The leopard's back feet dragging, dragging, pulling this thing down." The victim might have weighed 220 pounds,

the leopard no more than 90. But the contest was brief. With the leopard locked on its throat, the giraffe kicked futilely and then suffocated.

Stander jotted a few notes on his right knee: "Giraffe male, 1-2 months. Stalk distance 24 meters. Prey distance 5 meters. Struggle 1 meter." It was a terse summary of the terrible scene at our feet. Then we turned and headed back down the ridge to our vehicle.

Over the course of a few days, we had begun to know the local leopards almost by personality. But I realized with a start that, except for the one animal we'd trapped, we hadn't actually seen a single leopard in the flesh. They were living undetected all around, leaving their stories in the sand to be interpreted only by Tkui, Txoma, Flip Stander and a few other masters of the language.

IT SEEMED TO ME THAT LEOPARDS had left their footprints not just on the African earth but also in our own genetic heritage. One time in Botswana's Okavango Delta, I went out with a friend named Dave Hamman to inspect a sausage pod tree. It was a big old monster of a tree, 8 feet across at the bottom and maybe 40 feet tall. It was just the shape that humans find innately appealing, scientists have suggested, because its great, spreading branches would have provided our simian ancestors with some refuge from leopards. It's what we really mean when we talk about a picturesque tree. The sausage pod tree was also a species monkeys loved to visit to feed on its huge seedpods. But this tree contained a surprise: the trunk divided about six feet off the ground, and there was a deep hollow just below the split, with a worn-smooth lower lip, and a sort of knob like a stoop just outside. A leopard was said to be using the hollow as a den for her cubs.

We found the leopard herself a half-mile down the road. She lay in the shade, panting. With binoculars I looked into her vast khaki-colored eyes, and the crimson veins at the edge of the cornea seemed to swell and darken as she stared back. She closed her eyes again, and her head inclined. She moved off after a bit, and when she stepped into the tall grass, she vanished like one of the players in *Field of Dreams*. Her yellow fur blended perfectly with the dry grass blades. Her black spots disappeared among the dark spaces where the blades of grass crossed one another close to the ground.

Hamman figured the leopard was heading homeward, and we drove ahead to wait at the sausage pod tree. We passed a half-hour or so trading leopard lore. I told him about a recent study on vervet monkeys on Barbados. Neither these monkeys nor any of their ancestors had actually seen a leopard since their importation from West Africa in the mid-16th century. But they still panicked at the sight of leopard spots. It was apparently embedded in their genes. Richard Coss at the University of California, Davis has suggested that a similar genetic heritage may be the reason kings, tribal leaders and fashionable women are inclined to favor leopard-print clothing: leopards still make us a little gaga.

Just then, the female showed up. She paused and snapped at a fly that was bothering her. Then, as she approached the sausage pod tree, she made a soft coughing sound, to let the cubs within know mama was home. She leaped up onto the knob of the tree. She peered into the den. Then she squeezed her way down into the narrow opening. Her tail lingered outside. But after a moment, it vanished, too, and the tree became just a tree again, betraying no hint of the fierce life huddled up in its heart.

A 2-million-year-old fragment of hominid skull preserved at a South African museum bears evidence of puncture marks that match up with the teeth on a leopard's jaw, left.

Richard Conniff, a frequent contributor to these pages, wrote about Blenheim Palace in the February issue. Photojournalist Jim Leachman is based in San Francisco.

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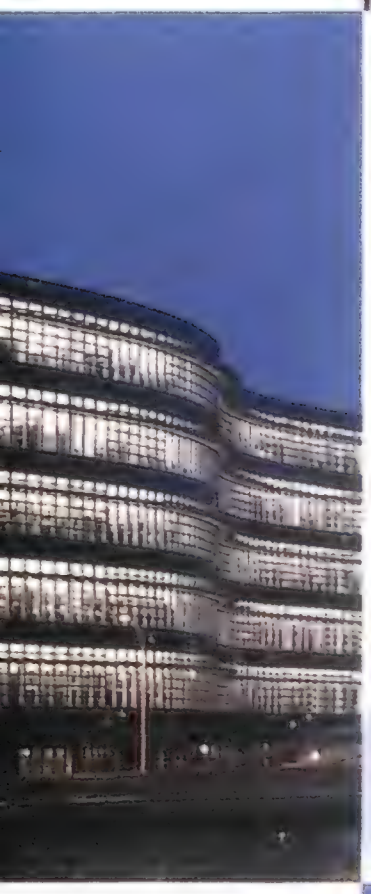
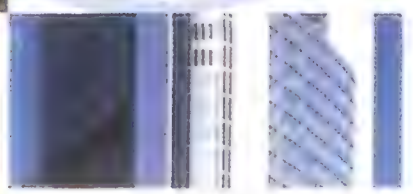
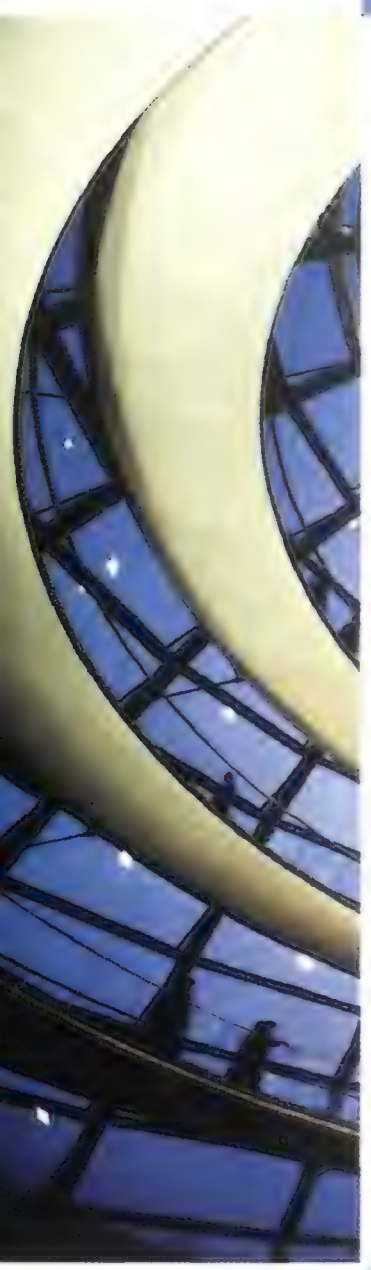


THE ASCENT OF glass

BY JEFFREY HOGREFE

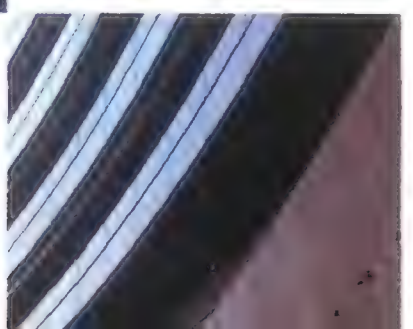


ADVANCES IN PRODUCTION, ENERGY EFFICIENCY AND METHODS OF CONSTRUCTION HAVE ENABLED GLASS TO RISE TO NEW HEIGHTS AND ASSUME UNEXPECTED FORMS



"THIS IS PROBABLY THE LARGEST TENSION-SUPPORTED GLASS WALL IN THE UNITED STATES." Todd H. Schliemann, a partner in the New York City architectural firm of Polshek Partnership, meets me in front of the Rose Center for Earth and Space at the American Museum of Natural History on Manhattan's Upper West Side. Looking up at the soaring 95-foot facade of the glass cube, I experience a jaw-dropping awe usually reserved for natural phenomena like geysers. I slowly take in the gravity-defying physics of a wall of 5/8-inch-thick transparent "water-white" glass that is held in place only by a thin network of interior clamps, trusses and bolts. Due to the super clarity of this special grade of optical glass—the same crystal-clear quality used in eyeglasses—the building seems to be made of air.

One of the most striking of the transparent glass buildings that are appearing like ghostly apparitions in cities around the world, the Rose Center marks a new age in glass architecture. Not since the early 1950s, when sleek, green-tinted glass buildings like New York City's Lever House rose amid the stone canyons of countless major cities, has glass elicited so much attention. There are so many glass buildings currently on the drawing boards or under construction, in fact, that it is hard to keep track of them all. This September, a 51-story glass-walled office building, using the same super-clear glass as the Rose Center for its lower floors, will open in the Chicago Loop. A few months later, architect Rafael Viñoly's Kimmel



The bold design of the elliptical Glass Hall of Rafael Viñoly's Tokyo International Forum, with its 187-foot-high transparent curtain wall, glass ceiling and zigzagging bridges, is a tour de force of structural engineering.

Center for the Performing Arts, with its 357-foot-long vaulted roof of transparent glass, will be inaugurated in downtown Philadelphia. "Glass is back," says Kenneth Frampton, professor of architecture at Columbia University and author of *Modern Architecture: A Critical History*. And now it's taking center stage.

IN THE 1920S, SWISS ARchitect Le Corbusier observed that the history of architecture is the history of the window. In the new glass buildings, says architect James Polshek, founding partner of Polshek Partnership and lead designer of the Rose Center, "the window has broken out of the frame." Architect Santiago Calatrava (SMITHSONIAN, November 1996) has located a foundry in his native Spain that will bend transparent glass to follow the outline of a ship's prow. In his expansion of the Milwaukee Art Museum, due to be completed this fall, the atrium looks out onto Lake Michigan through a 90-foot-tall bow-shaped wall, giving visitors the impression they are sailing out onto the water. In Japan, glass soars to dramatic heights in the 47,000-square-foot glass hall of the New York-based Viñoly's 1996 Tokyo International Forum. In Berlin, a mirrored-glass column rises up the center of London architect Norman Foster's new 77-foot-tall glass dome for the historic German Reichstag. In upstate New York, a glass staircase leads the way to the new library at the Corning Museum of Glass, and in London, diners at the Now and Zen Restaurant literally walk on glass as they approach the entrance.

Shown here shortly after completion in 1952, Skidmore Owings & Merrill's landmark Lever House was one of the first glass curtain-wall buildings in New York City.

Like the Rose Center, many of the new glass edifices are signature buildings. That is to say, the structure itself is used to communicate a message to the public about the occupants' underlying philosophies. "We wanted to build a structure that would say science," says Polshek. In the year since the Rose Center opened to the public, it has drawn crowds beyond the wildest expectations of the museum's directors. Many people go just to see the pristine glass cube, which houses the spherical aluminum Hayden Planetarium as if it were a ship in a giant glass bottle. The museum's directors were initially reluctant to give the green light to such an experimental system of glass construction because nothing like it had been used here in the United States. Although many of the icons of early glass architecture rose in U.S. cities during the years after World War II, since the energy crisis of 1973 most of the advances in glass architecture have taken place in

EZRA STOLLER/ESTO. P. 80 AND P. 81 JOHN LINDEN/ESTO

The "world's first ecological high-rise tower," Norman Foster's triangular Commerzbank in Frankfurt boasts a glass atrium, operable windows and a series of four-story gardens.

Europe. The directors approved the design only after a trip to France to see the building's prototype, the Cité de Sciences & l'Industrie, in Paris. Completed in 1986, the museum used an innovative structural device designed by the Paris-based firm of Rice Francis Ritchie. The system suspended the glass wall in front of a series of metal trusses and braces that held the glass panels in a state of tension.

Glass has many virtues. It lets in light, and brings the outside in and the inside out. Glass is also impervious to the effects of most harsh chemicals and thus is less susceptible to damage from acid rain, which eats away at masonry buildings. Furthermore, advancements in glass production since the 1973 energy crisis have resulted in revolutionary changes in its performance.

Kenneth Frampton sees the return to glass buildings as a symbol of progress. "We do see glass coming back, and with the comeback it has to be effective environmentally," he says. "The early glass curtain wall was only slightly more efficient than no wall." The new glass is not only spectacular to look at and through, it is also more efficient and much safer than the old glass. Stringent energy codes have led to many innovations. Glass is now being manufactured with special coatings that adjust the thermal intake for all four directions of the compass and even allow for the increased intensity of the sun at certain latitudes. For the new LVMH (Louis Vuitton Moët Hennessy) building, which opened in midtown Manhattan in 1999, more than 30 different types of glass were used in the curtain wall in order to meet New York City's energy codes and create an arresting facade of contrasting textures and colors.

Old glass buildings, too, are benefiting from the improvements in glass. Completed in 1952, Park Avenue's Lever House, designed by architects Skidmore, Owings & Merrill, was one of the first glass-walled buildings in Manhattan. Earlier this year, construction was finished on a two-year renovation, undertaken because the original glass had begun to crack. The structure has now been completely reclad with a new, stronger version of the PPG Solex glass originally used in the building.

"Glass is being argued as a new material," notes architect Robert A.M. Stern, dean of the School of Architecture at Yale University. "It's being rediscovered after a generation of architects who rejected it." For most of his illustrious career, Stern has been a champion of traditional building styles and materials. At 62, he has climbed onto the glass bandwagon. His New

P. 40 AND P. 83 IAN LAMBOT | SAIF AND PARTNERS

Rising up the core of Foster's new glass dome for Berlin's Reichstag, a conelike column sheathed in angled mirrors reflects natural light from the ramp-ringed cupola.

York firm is currently working on a design for a modern-style office building with a curtain wall of clear, water-white glass, constructed in a similar fashion to the Rose Center. And, in response to his students' growing interest, Stern has added a seminar on glass curtain-wall technology to Yale's curriculum for the fall.

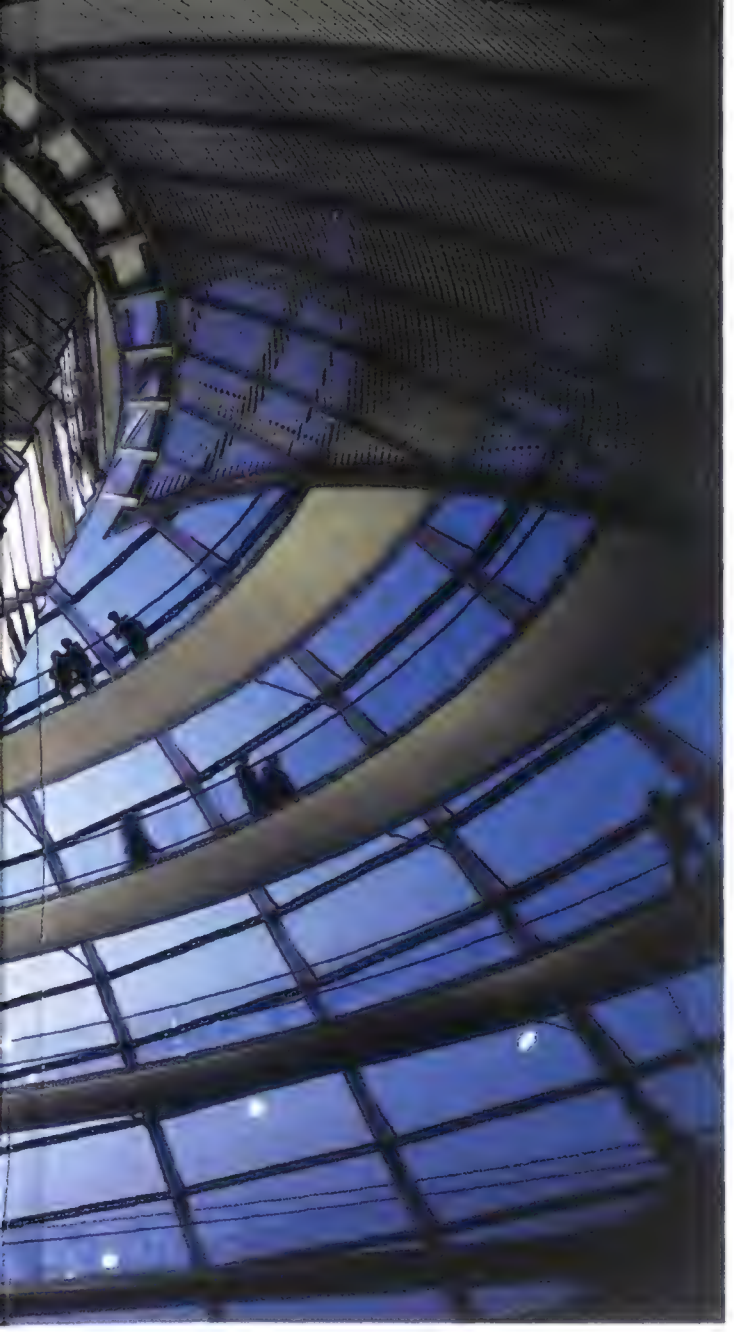
"There are hundreds of thousands of formulas for glass," says Rob Cassetti, creative director of the Corning Museum of Glass. In general, most glass is made of three basic materials—silica-based sand, crushed limestone and sodium carbonate—which are combined to form what's known as batch. The color and transparency of the finished glass depend on the composition of the batch. "If you want a transparent glass, you have to use sand with a higher content of silica," explains Cassetti. "Silica is a colorless crystalline compound that's found in quartz, and it's also what gives glass its tensile strength. If you want water-white glass, you have to find the purest grade of sand with the lowest levels of iron. Then you have to add decolorants to counteract any remaining traces of iron, since that's what gives glass its greenish hue."

Temperatures in excess of 2,500 degrees Fahrenheit are then applied to the batch, causing a chemical and physical transformation that converts the opaque solid batch into a transparent hot liquid. In this molten state, glass can be molded and shaped into myriad forms. Most window glass is made using the float method, invented in 1959 at the Pilkington Glass Works in Great Britain. The molten glass is floated on a bed of molten tin. The glass spreads over the surface of the molten tin and cools into a smooth, hard sheet. "At a molecular level the tin is acting like billions and billions of little ball bearings rolling across the glass," says Cassetti. The finished glass forms as the molten liquid is cooled. This decrease in temperature creates a molecular arrangement that produces a distinct "glassy" state of matter that has the rigidity of a solid but a chemical structure similar to a supercooled liquid. Technically speaking, the molecules are arranged randomly as they would be in a liquid, but the final product solidifies before the molecules have time to form ordered positions, as in crystals, metals and many other solids.

Why, then, does glass break? "The surface of glass would be very strong except that there are flaws everywhere," explains Steven E. DeMartino, a research scientist at Corning. "The flaws are where breaks begin. Flaws can be internal to the glass or as simple as a surface scratch." Glass can be strengthened, however, by a process called "tempering," which involves reheating the glass until it almost softens and then rapidly and uniformly cooling it again. This causes the surface of the glass to go into extreme compression. "In this way you armor the glass from breaks," says DeMartino. So-called bulletproof glass, in fact, is not really bulletproof. It's actually a sandwich made out of layers of glass and plastic linings that absorb the impact of a bullet. A similar type of glass, whose inner layers are composed of extremely strong tempered glass with the weight-bearing capacity of steel, is often used for staircases and floors.

To protect people from being hurt, glass can be laminated with a thin polymer coating that causes the broken pieces to stick together in a web. This is the type of "safety" glass that is used on the windshields of cars, trucks and many planes.

Glass can also be coated, either during or after the manufacturing process, with special films that make it



more energy efficient. For added insulation, manufacturers layer the glass in double and triple panels. Many early glass buildings used glass that was either tinted green or darker colors like gray and bronze, to absorb or reflect varying amounts of the sun's rays. Mirrored coatings were also applied to reflect the sun.

Glass attracts attention and creates a sense of drama. No other material could have achieved the luminous effect of the glass pyramid that I. M. Pei set in front of the Louvre in 1988—another early example of a water-white glass building. At night, the lit pyramid acts as a beacon, inviting people to the darkened 19th-century stone facade of the museum. Norman Foster's glass dome for the restored Reichstag was designed to represent "the strength and vigour of the German democratic process." The Reichstag has a tortured history. It was built in the 1880s by Otto von Bismarck as a symbol of a unified Germany. Damaged by fire before the Nazi government seized power in the 1930s, the building was defaced by the Communists in the 1940s. Glass is used extensively in the building to reveal, soften and unify its historic elements. Glass is also a unifying force in Foster's recently completed dome for the British Museum, which soars to a height of more than 100 feet to enclose the two-acre interior court of the neoclassical complex. In French architect Jean Nouvel's Fondation Cartier building in Paris, oversize planes of clear glass unite to create an arresting diaphanous facade.

Glass can serve as a lens, revealing and bringing into focus the interior of buildings—as in the Rose Center, and in the award-winning Hillier Group design for the power plant that supplies electricity to New York's John F. Kennedy International Airport. The inner workings of the plant are exposed to view through the building's transparent glass walls. Unlike traditional power plants, which disguise themselves as other types of buildings, the JFK design is as honest as it is bold. "The underlying point of the design was that power is beautiful," says project architect David Finci.

GLASS' PARADOXICAL NATURE, at once weak and strong—a wall that is not really a wall—makes it a powerful material. Lavish use of glass in architecture makes a statement about the underlying confidence of the occupants of a building. Business people arriving at architect Kisho Kurokawa's shimmering new air terminal in Kuala Lumpur—one of the largest airports in the world—are reassured by the extensive use of glass that they are entering a confident, forward-looking nation. "The goal was to give people a positive first impression of Malaysia," says Kurokawa.

Glass is innovative. For his 53-story Commerzbank in Frankfurt, Europe's tallest building, Norman Foster created what's also billed as "the world's first ecological high-rise tower." The three sides of the triangular building enclose a glass atrium. Four-story-high gardens are placed at intervals in each of the three sides in such a way that all offices look out on greenery. Unlike most glass towers, which usually have sealed windows, the windows in the Commerzbank open. Rafael Viñoly's glass canopy for the subway entrance at his Tokyo International Forum employs a specially engineered fastener that allows the glass panels to extend out in a dramatic transparent arch.

"Historically, there's nothing whimsical about the use of glass in architecture. From the beginning, glass has been an ally to commerce." Henry Smith-Miller is sitting behind a large table at the New York firm of Smith-Miller + Hawkinson, which he runs with his wife, Laurie Hawkinson, a professor of architecture at Columbia University. For their all-glass design for the new Orientation Center at the Corning Museum of Glass, which opened in 1999, the pair conducted extensive research on the history of glass.

Glass was invented approximately 4,000 years ago in the eastern Mediterranean, probably by a potter who inadvertently mixed the fused silica from his pots with the alkaline ash in the hearth below his kiln. In his *Ten Books on Architecture*, a lengthy description of building types in ancient Greece and Rome, the Roman scholar Vitruvius did not mention glass, a fact that led historians to conclude that glass windowpanes were highly unusual in the ancient world. Nonetheless, glass windowpanes were discovered in the ruins of Pompeii and, in Rome, evidence was found that glass was used in the construction of small

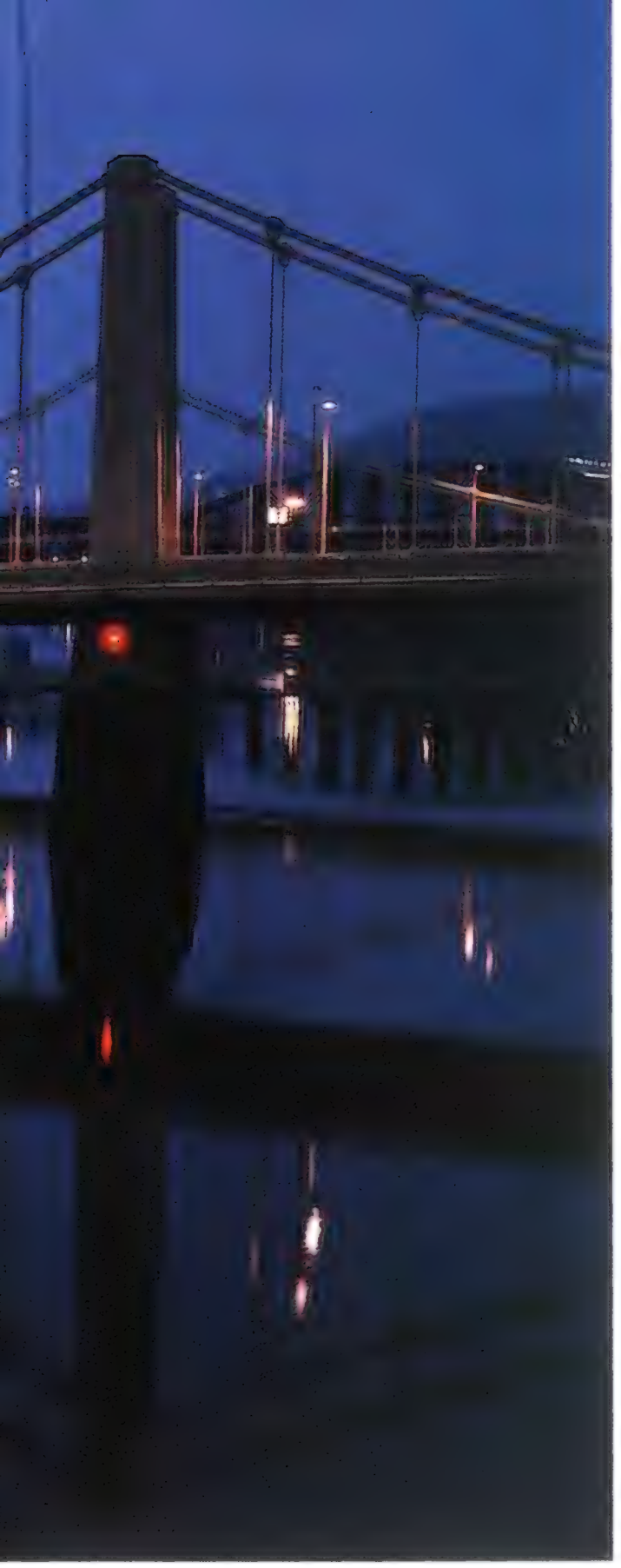
The undulating glass facade of the Alcoa Corporate Center in Pittsburgh admits natural light by day and glows like a beacon at night.

greenhouses. "They were more like primitive forcing frames that could be moved from place to place," says Smith-Miller, who is fascinated by the evolution of the greenhouse—the forerunner of the modern glass building.

"The English developed little glass boxes to put on ships when they moved plants from continent to continent. They were waterproof because saltwater kills plants," Smith-Miller explains. He shows me a couple of pictures of orangeries—elaborate greenhouses that were built in the 16th century to house orange trees in cold climates. "These were not fanciful," he notes. "They were a practical response to commerce.

"We know today that when people look out of a window, they believe that they own everything in sight," continues Smith-Miller. "This belief arose at the time of the construction of Versailles [see page 90] in the 17th century. Until then, buildings were mostly forts. Then there was King Louis XIV, who was so powerful he didn't have to fortify himself. In the palace at Versailles, the stone disappears and becomes glass, which looks out over a vast estate."

In the 19th century, glass greenhouses increased in size with the perfection of structural iron frameworks. Of all the glass buildings of that era, the best known is the enormous Crystal Palace, built in London in 1851 for an international exhibition celebrating industry and manufacturing. The structure measured 456 feet by 1,848 feet and was composed of more than 300,000 panels of glass—a third of



England's annual production. In winter, the cost of the palace's heating supply taxed its resources. In summer, it could become as hot as a furnace, making it virtually uninhabitable.

Creating a habitable all-glass building continued to fascinate designers. For the 1914 Werkbund Exhibition in Cologne, architect Bruno Taut, one of the leading members of a group of German architects and artists who had been inspired by the writer Paul Scheerbart's recent volume *Glasarchitektur*, designed the first structure to illustrate the varied potential of glass.

Ludwig Mies van der Rohe, the subject now of concurrent exhibitions at the Museum of Modern Art and the Whitney Museum of American Art in New York City, is generally regarded as the father of the modern glass-walled building. His 1921 design for an unbuilt glass skyscraper has been studied by architects for generations, and his Seagram Building in Manhattan and Farnsworth House in Plano, Illinois, are masterworks of modern glass architecture. One of his most noted protégés was Philip Johnson, whose famed 1949 see-through glass house in New Canaan, Connecticut, would become a classic of the genre. In the late 1920s and early 1930s, at the Bauhaus in Dessau, the pioneer German school of design, Walter Gropius and Mies van der Rohe produced glass buildings made out of transparent factory windows. Smith-Miller shows me an old photograph of a glass-walled building. "This was the first glass curtain wall," he tells me. "In Germany, architects were banding together to figure out how to design a wall out of glass. But in America, a lone architect came up with the design on his own." The architect was Willis Jefferson Polk. In 1918 he designed a glass-walled reinforced-concrete structure in San Francisco that predated the European glass buildings by more than ten years.

Even up to the middle of the 20th century, glass was a vulnerable, experimental material. The glass-walled skyscrapers designed in the late 1950s by Oscar Niemeyer for Brasilia became so hot that the occupants lined their windows with aluminum foil to reflect the heat. And in the early 1980s, windows began popping out of Boston's John Hancock Tower due to an unanticipated interaction between the lead solder used to hold the glass in place and the film of reflective chromium that coated it. Such incidents added to the public's concern over the safety of glass.

"Everyone believes that glass is a little dangerous. It can break. You can't see it. Basically, we introduced an element of apprehension into the experience of going to this place." Smith-Miller guides me into the new lobby of the Corning Museum of Glass, his addition to the original 1956 International Style glass-walled building designed by architect Wallace Harrison. There is so much glass at such unlikely angles in the new addition that the overall effect is a little unnerving. "Instead of using glass as a substance to be looked through, we also wanted to use it as a substance to look at," says Smith-Miller. Entering the lobby, we pass under sloping sheets of 1-inch-thick glass held in place by a delicate network of metal spider clamps. "The walls and ceiling are not parallel to the floor," explains Smith Miller, "so the glass seems to mysteriously float around and over our heads." The wall was purposely tilted, he says, "so that when you are next to it you have a physical relationship to the glass itself. You normally think of glass as transparent and invisible. Not so here."

MARTIN POWELL, A PRINCIPAL in the Pittsburgh firm of Design Alliance Architects, stands by a large, old plate-glass window on the 24th floor of a 1910 office tower in downtown Pittsburgh. Pointing to the street below, he gives me a lesson in the genesis of glass architecture. On one side is a 1949 International Style building by Wallace Harrison. Across the way he gestures to what looks like a stylized version of a Gothic cathedral clad in mirrored glass. The headquarters of PPG Industries, the building was designed by Johnson/Burgee Architects in 1980. "Those mirrored glass buildings went up in the early 1980s as a response to

Angled planes of transparent glass supported by small metal spider clamps compose the facade of Smith-Miller + Hawkinson's new addition to the Corning Museum of Glass.

the energy crisis," Powell explains. Then he points to a small all-glass structure across the Allegheny River—the Alcoa Corporate Center, which opened for business in 1998. In the afternoon sun the facade catches the light reflected on the water and sparkles like a jewel. "We probably couldn't have built this building in downtown," says Powell. "It needed some space around it. The client wanted to have large floors with high ceilings for open-plan offices that would encourage communication between departments." The inspiration for the building derived from the piano-curve designs that Le Corbusier introduced in the 1930s. In many ways, Powell considers this building to be a successful reiteration of those early glass buildings that leaked and racked up high energy bills.

"We suggested glass because the client wanted high ceilings and daylight. The technologies are very difficult because we have a lot of sunlight that we had to control without glare." Powell points to the clear, water-white glass wall. "The long facade faces south and has harsh winter light that you can't get away from, so we designed overhangs that work like visors on a cap." As we approach the building Powell explains that the design was not intended to be faddish, but to be efficient. "We harvested daylight with horizontal louvers that would bring light deep into the building," he tells me, gesturing to the louvers on the windows at the top of every floor. Like most of the new glass buildings, the Alcoa Center is a high-performance structure that only heats and air-conditions those parts of the building that are in use. "The temperature up there reaches 85 degrees," Powell says, pointing to the ceiling area. "Down here it remains between 65 and 75 degrees because we are in the path of recirculating air that comes up from the floor."

"Glass is an important energy material. It is energy-intensive to create, but there is no other material that does what it does," says Muscoe Martin, a principal in the Philadelphia firm of Susan Maxman & Partners, and a specialist in "green" architecture. Martin notes that glass is now used not only to harvest light, as in the Alcoa building, but to create electricity by means of photovoltaic panels. Martin's firm just completed a building at Ohio State University that used a new product called superwindows—energy-efficient panels made up of a transparent film sandwiched between two layers of glass that are assembled in an aluminum frame and have almost the same insulating value as a two-by-four wall with fiberglass insulation. "These panels are much more expensive to use than regular glass," says Martin. But the cost is offset by a smaller, less-expensive heating and air-conditioning system and reduced energy consumption.

ON THE WAY OUT OF THE Alcoa building, Powell stops in the lobby to show me the way coatings can affect the performance of glass that is in direct contact with the sun. The west-facing window looks out on the bridge over the Allegheny, just a few feet away. But because of the extra lamination of the glass, which added a third layer to the sealed glass unit, there is very little noise from the bridge traffic. What's more, the sun is pouring in, but when I put my hand on the clear, untinted window, the glass actually feels cold to the touch.

"It's amazing," says Powell, "the way glass has gone from being a material that was beautiful but difficult to work with to a material that's now one of the most versatile you can use."

Brooklyn-based writer Jeffrey Hogrefe lives in a 19th-century brownstone, not a glass house.

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RENAISSANCE OF THE GARDENS OF *Versailles*

BY RICHARD COVINGTON

PHOTOGRAPHS BY
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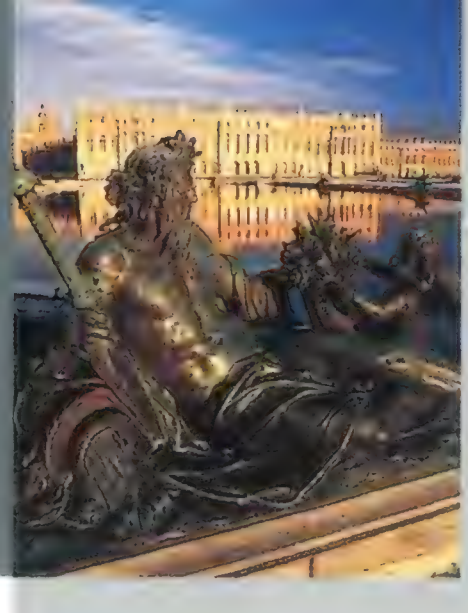
The Parterre de l'Orangerie is the summer home for movable containers of orange trees, palms and flowering plants. Around the pools of the Parterre d'Eau are eight principal statues, including "The Seine" (right), a personification of the river.



AFTER VIOLENT STORMS DESTROYED THOUSANDS OF TREES IN 1999, FEARS OF DISASTER EASED WHEN THE CLEANUP REVEALED PANORAMAS UNSEEN FOR CENTURIES, FITTING NEATLY INTO A 25-YEAR RESTORATION PLAN

UNDER LEADEN SKIES, LAURENT CHOFFÉ IS rallying his troops. Choffé's team of gardeners, landscape architects and metalworkers are racing to put the finishing touches on the restored Bosquet du Dauphin, one of the oldest groves at Versailles. Sunk in mud up to their calves, a pair of sweating workers struggle to maneuver a heavy section of pipe to fit it into the fountain. After watching them slip, slide, heave and get nowhere, Choffé suggests they take a break. As a light rain starts to fall, he turns to the crew to discuss the urgent matter at hand—where to set up the tables for the *pot* (pronounced "po"), the traditional workers' celebration, marking the grove's completion. What if the rain delays the event, I ask. Will there still be a pot?

Smoke from bonfires fills the air around the château as crews clear the remains of 10,000 trees destroyed by deadly storms that blasted across Western Europe in December 1999.

Choffé shoots me a quizzical look. "*Mais oui, Monsieur, le pot est sacré!*" he says with a Gallic shrug and tongue firmly in cheek. It's vintage Versailles; even if the weather won't cooperate, the restoration—and the fete—must go on.

The wrestling match between man and nature is an old, old story at Versailles, the former seat of French kings, 13 miles west of Paris. In the 17th century, Louis XIV, the Sun King, created the perfectly trimmed, geometric garden to show his control not simply over his subjects but over nature itself. Versailles sets the standard for the formal French style, with its rigidly linear Cartesian perspectives, clipped hornbeam hedges, flower beds of curlicue greenery and exuberantly baroque fountains, sprouting gilded gods, frogs and cherubs.

When 105 mile-per-hour winds ripped through the park in December 1999, uprooting 10,000 trees and peeling away the château's lead roofing, it looked as if nature were wreaking her revenge. Trees planted at the end of the 18th century, when Marie Antoinette was playing the amorous shepherdess in her jewel-box theater, were flattened. A cherished Corsican pine, planted when Napoleon ruled—in reality, a remarkably chintzy emperor when it came to gardens—was gone with the wind. Roots four times as tall as a man were yanked from the earth, leaving craters the size of small swimming pools. The government brought in army crews from as far away as New Caledonia and French Guiana to help the 50 staff gardeners.

Although I live close to Versailles, I was away with my family in Nuremberg during the storm. Even there, some 500 miles to the east, the winds scythed down forests and gnarled umbrellas into wire sculptures. When we returned home, we were dismayed to see that two-dozen roof tiles had blown away and that our neighbor's 50-foot pine had demolished a stone wall in our backyard. (This was no great loss: the pine was shading our terrace, and we wanted it gone anyway.) We counted ourselves lucky. Across France, 90 people were killed in the tempest that destroyed some 741,000 acres of forest.

When I visited Versailles shortly afterward, I was stunned by what I saw. Many of the graceful gardens and secluded groves looked like logging camps; bonfires dotted the landscape, and pungent smoke from burning green timber wafted across the chill air. Bulldozers and backhoes executed a clumsy, deafening ballet where the various Louises and their courtiers had once intrigued and gamboled. Wide swathes of the park were closed to the public as gardeners-turned-lumberjacks labored to clear away the fallen trees.

Jacques "Jacky" Durand, one of those gardeners, has tended the rambling woods of Trianon park and the mock-farming village of the queen's Hamlet for nearly 25 years and knew every tree. Months after the storm, Durand, a trim, soft-spoken man, still winces as he recalls his first day back at work.

"Every one of the gardeners, myself included, had tears in his eyes while clearing away the damage," says Durand as he guides me across the Hamlet, pointing out bare spots where trees had been. "It was as if the storm had ripped something out of every one of us. We couldn't walk along the broad *allées*, and we had to climb over branches like monkeys to make any headway."

As I gaze out over a pleasant rolling meadow carpeted with new grass, Durand brings me up short. "Doesn't look too bad now, does it?" he inquires with a wan smile. "But that treeless meadow was dense with at least 300 trees. The storm tumbled them like dominoes."

On the bank of the Hamlet's pond, the gardener indicates the spot where a 200-year-old tulip tree crashed down on a young 30-foot cypress with such force that it smashed the cypress to smithereens. "Replacing trees like those will take generations," he tells me.

To Durand and visitors like me who witnessed the storm's aftermath, Versailles looked like a total disaster. It was not. As it turned out, the worst storm in French history folded neatly into an ongoing 25-year master plan for restoring the park. "We have to avoid giving the storm too much importance," explains Pierre-André Lablaude, the park's chief landscape architect. "There was considerable damage, but it also caused trees to fall that we planned on cutting down anyway, so the storm accelerated a process we had already begun." As Lablaude ranges about his office, he consults precisely rendered 17th- and 18th-century drawings of the gardens on the walls, pointing out areas where the renovation of the 369-year-old park is under way.

The long-range plan was initiated in 1990 after a freak storm knocked down 1,300 trees, a record until the 1999 devastation. Scheduled for completion in 2015, the plan calls for returning the 230 acres of the main palace gardens to the original 17th-century design by André Le Nôtre. The gardens surrounding the Petit Trianon, a stately neoclassic manor house, and the queen's Hamlet will be restored as they existed in the late 18th century, when Louis XVI's young wife Marie Antoinette retreated there from the prying eyes of the Bourbon court. Including the Grand Trianon—a sprawling retreat the Sun King constructed for his second wife, Madame de Maintenon—and its gardens, today's Versailles takes in some 2,000 acres.

The glaring weakness of the park was that many of the trees had grown too tall to thrive on what was originally marshland. In Le Nôtre's design, tree heights were limited to 36 feet, but some venerable giants grew as high as 120

Pierre-André Lablaude, chief landscape architect, compares the 1677 engraving of the original appearance of the Bosquet de l'Encelade created by Le Nôtre with the 1995-1996 renovation of the grove (background). In the center of the pool is the gilded statue of Enceladus.

On a foggy morning visitors cycle along the North Allée that runs next to the Grand Canal. The linden trees that line the allée were planted in 1947 and have just reached the perfect height, according to the master design. With proper care they have a life expectancy of another 50 years. The smaller trees, bottom left, were recently planted.

feet. While some oversize trees had been cut down intentionally, those toppled by the storm also benefited the master plan. "We rediscovered magnificent panoramas that had been completely obscured," says Lablaude.

The first thing that strikes post-storm visitors is just how remarkably undamaged the park looks. The trees that were wiped out represent only 5 percent of the park's total. Large sections of the park have been fenced off where 4,000 new trees—lindens, horse chestnuts, hornbeams, tulip trees and poplars—have been planted, and plans for another 6,000 trees are in the works. "Within 10 to 15 years, we'll have the perfect view," predicts Lablaude.

Despite opening up the forest and leveling some aged trees, the storm left a stream of red ink in its wake, wreaking $16 million in damages to the château and $18 million in damages to the park. Miraculously, the wealth of antique statuary dotting the park escaped harm. "The trees were very polite," says Hubert Astier, president of the museum and park. "They fell beside the statues, not on top of them, except for one that had a leg broken off." Through the open window of his office we hear the incessant crunch of sneakers walking on pebbles, the signature chorus of Versailles' ten million annual guests.

By far, the largest number of foreign visitors are American, drawn by the sumptuous extravagance of the palace and the historic connections between France and the United States that date back to the late 18th century when Benjamin Franklin and Thomas Jefferson were ambassadors to the French court. It was at Versailles that France committed itself to sending troops and arms to fight for the American Revolution and where the British signed the treaty ending that war. And it was at Versailles in 1919 that President Woodrow Wilson signed the treaty ending World War I.

We hear the incessant crunch of sneakers walking on pebbles, the signature chorus of Versailles' ten million annual guests.

After the storm, Americans were among the first to volunteer their help. Of the 2,000 people paying to finance the planting of new trees under Astier's adopt-a-tree program, 500 are American. American largesse dates back to 1924 when John D. Rockefeller, Jr., shocked by the dilapidated palace and gardens, donated nearly $1 million toward their restoration, and over the years, the Rockefeller family has injected another $23 million. Other Americans, as well as the Kress Foundation and the World Monuments Fund, have donated money and antiques. Recently, the American Friends of Versailles has raised more than half of the $3.5 million needed for restoration of the Bosquet des Trois Fontaines, one of 14 elaborate groves with fountains, statuary and topiary that Astier intends to restore in part with private funds.

Astier's plans for Versailles are nearly as ambitious as those of Louis XIV, fueled by the government-mandated reacquisition of buildings and grounds that were once part of the prodigious royal domain. He envisions a research center devoted to European civilization in the 17th and 18th centuries and a school of equitation. Gérard Vié, the renowned chef of the local Michelin two-star Les Trois Marches restaurant, has been enlisted to open two new restaurants on the grounds. There's even a plan to put small, motorized ferries in the Grand Canal to swan passengers the half-mile jaunt to Grand Trianon, though how they would maneuver among the rowboats and sculls already there is anybody's guess. Astier is not worried. In Louis XIV's day, the Grand Canal was jammed with gilt gondolas, a bark reserved for Jean-Baptiste Lully's orchestra, and pint-size warships.

Before acquiring a taste for ruinous wars, the young Sun King certainly knew how to throw a party. Between 1661 and 1682, when the palace was largely a construction site, the gardens were a movable feast of plays by Molière, music by Lully.

Le Parterre du Midi is the garden that flanks the south side of the château, background; its carefully trimmed and shaped boxwood hedges outline a spectacular presentation of flowers.

The Bassin de Neptune provides a dramatic stage set for fireworks, fountain displays, music and revelry, to entertain summer visitors during *Les Fêtes de Nuit*. Local actors (above) don period costumes and re-create Louis XIV's extravagant parties.

ballets with Louis dancing as a costumed Apollo, fountain shows and incomparable fireworks displays that painted the night sky with light. The whole symphonic concoction served as an immense, well-oiled propaganda machine. Underlying the dazzling revels, pleasure gardens and allegorical statuary was the unmistakable message of the king's absolute power and glory.

True to Louis' predilection for spectacles, Astier has opened up the palace and gardens to summertime extravaganzas. *Les Fêtes de Nuit* is an interpretation of the king's passions for hunting, dancing and mistresses. This giddy charade features a costumed cast of 200 (most of them local amateur extras), hunters on horseback charging around the Bassin de Neptune with a pack of Irish hunting dogs, fountains that spew sparkling gushers of fire and others that send water sprays soaring 70 feet into the air. This wordless pageant is witty and delirious, with a crescendo of fireworks surpassing any I've ever seen.

One pellucid Sunday afternoon in July, I join the crowds gathered for *Les Grandes Eaux Musicales*. For 90 minutes, visitors promenade like Louis XIV and his courtiers, listening to the music of Handel, Lully and Jean-Philippe Rameau and marveling at the waterworks. As the taped baroque music resounds through the garden, I wander down to the recently restored Bosquet de l'Encelade, dominated by a soaring colonnade of arched trelliswork topped by gilt urns. In the center, water spurts from the mouth of the gilt giant Enceladus, crushed beneath a rain of rocks, also spurting jets of water. According to Greek myth, the giant made the fatal mistake of challenging Zeus and was buried under the stones of Sicily for his effrontery. To any nobles who might dare challenge the king, the lesson of retribution was clear. All they had to do was to look around the gardens. Key pieces of statuary—and in fact Le Nôtre and the entire team responsible for creating the palace and park—had been summarily expropriated from the ill-fated Nicolas Fouquet, the finance minister,

who had committed the unpardonable mistake of outshining the king's sun.

In 1661 Fouquet threw a lavish party at his palace at Vaux-le-Vicomte, 33 miles southeast of Paris. Livid that an underling could flaunt a 6,000-guest blowout of music, ballet, fireworks and haute cuisine set against an ostentatious display of sculpture, painting and furniture, the 23-year-old Louis had Fouquet arrested for embezzlement and imprisoned for life. Soon after, the king packed off Vaux-le-Vicomte's sculptures and furniture, and commanded Le Nôtre, the painter Charles Le Brun, architect Louis Le Vau and horticulturist Jean-Baptiste de La Quintinie to lead the transformation of Versailles.

Louis couldn't have chosen a worst possible place to build his palace. Most of the surrounding land was marsh. But sentiment overruled practicality. Louis had a fondness for the place where his father had come to hunt deer and wild boar and decided to make the old stone-and-brick hunting lodge the core of his future palace. Perhaps just as importantly, Louis set his heart on Versailles because it was a place where he could escape with his new girlfriend, the striking Louise de la Vallière. Here he could be a world away from the court.

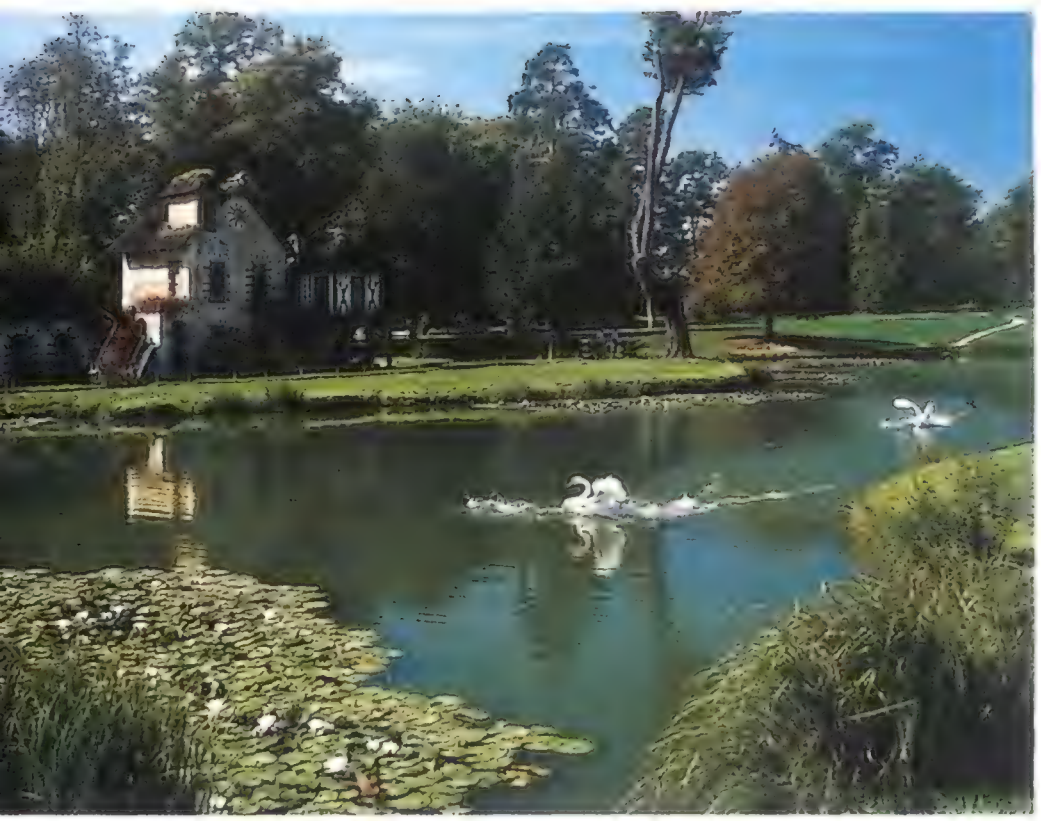
Besides, the more miasmal the setting the greater the challenge to the arrogant king. According to Louis de Rouvroy, duc de Saint-Simon, a historian who lived at court, Versailles was the "gloomiest and most thankless of places, without view, without woods, without water, without soil, for all is either sand or bog, consequently with an air that cannot be pure." The king, he wrote, "delighted in tyrannizing over nature, subduing it by force of art and money."

And force nature Louis did. Mountains of earth were moved to build up the land around the palace. Entire forests of fully grown trees were uprooted from 50 miles away and transported to Versailles, where they died by the thousands; but more were hauled in, and soon the woods began to take shape. Bending water to the Sun King's will proved an even more colossal undertaking. Le Nôtre drained the low-lying swamp into a giant cross and dubbed it the Grand Canal to flatter Versailles with comparison to Venice. Through an ingenious system of canals, ditches and pipes, water flowed from Rambouillet Forest 25 miles away to fill the 50 gravity-fed fountains. The Francine brothers invented pumps and windmills to recirculate water from the Grand Canal to the château's rooftop reservoirs. At the height of construction, there were sôme 36,000 laborers.

Despite these Herculean feats, Louis still did not have his dream—enough water to run all of the fountains all of the time. Instead, footmen sprinted ahead during his daily walks to turn the fountains on and off as he passed by. Ever determined, Louis decreed a truly megalomaniacal scheme to divert the Eure River, 26 miles away. A pharaonic task force, numbering 20,000 soldiers and 10,000 local laborers, slaved to erect a double-tiered aqueduct intended to rise a mind-boggling 450 feet. Unfortunately, Louis' focus shifted to yet another war. The troops

The centerpiece of the Bassin de Bacchus, created by the Marsy brothers in 1672, features a bronze statue of the god of wine surrounded by four satyrs.

Le Nôtre's groves are delightful, like living rooms of greenery inviting a visitor to sit and while away some time.



The queen's Hamlet at Trianon, with its mock farm and village in a bucolic setting, was a gift of Louis XVI in the late 18th century to his wife Marie Antoinette so that she might escape the gossip of the Bourbon court. The village was an elaborate stage set of rustic facades, with interiors filled with marble, gold and silks for the queen's use. She was in her nearby grotto when the mob arrived to force the royal family to Paris in 1789.

were dispatched, leaving the project forever unfinished. Today, the aqueduct to nowhere—only one story but massive nonetheless—ornaments a golf course.

Louis was obsessed by his gardens, hovering over the minutest detail. He wrote at least six versions of a slim guidebook outlining precise instructions on the proper route for inspecting the gardens. Later editions changed the prescribed tour so that the elderly, gout-afflicted monarch could avoid steps. Louis wielded a mean set of shears, excelling in the arts of pruning and grafting. He delighted in taking foreign emissaries to his high-walled kitchen garden to astonish them with the dizzying array of exotic fruits and vegetables growing under newfangled greenhouses. Serving lettuce in January and strawberries in March provided yet another demonstration of the king's power, proving that even the seasons bowed to his divine whim.

As willful and demanding as Louis was, he had the good sense to give the modest Le Nôtre a free hand in designing the gardens. When Le Nôtre was young, he was an apprentice to his gardener father, and helped create the Tuileries Gardens in Paris. Later, he oversaw the Luxembourg Gardens and Fontainebleau before Fouquet hired him for Vaux-le-Vicomte.

Le Nôtre was a genius at manipulating geometry and perspective, and he invented countless clever techniques for tricking the eye. While Versailles' grand axes, expansive parterres and almost too-perfect proportions are the landscape architect's signature pieces, it is in the hidden groves that Le Nôtre was truly inspired. Wandering along narrow paths, I stumble onto them by surprise. They are delightful, like living rooms of greenery inviting a visitor to sit and while away some time watching water spraying skyward, rippling down terraces or cascading over rocks.

For more than 20 years Le Nôtre was the uncontested master of the gardens, but gradually he was supplanted by Jules Hardouin-Mansart, a talented opportunist who slowly undid much of his teacher's work. Mansart, says Lablaude, wanted a garden in marble. In wheedling Louis' permission to destroy Le Nôtre's Bosquet des Sources and erect the Colonnade Grove, Mansart got his wish; a stark circle of Carrara marble featuring François Girardon's marble the "Rape of Persephone." The chiseled Colonnade made me pine for Le Nôtre's antic greenery and jaunty fountains. When Louis asked Le Nôtre what he thought of the makeover, the normally reserved old gardener shot back an uncharacteristically impertinent zinger of a put-down: "Well Sire, what do you expect me to say? You have made a stonemason into a gardener and he has served you a dish of his own making." Touché!

Le Nôtre exacted his revenge with the Salle de Bal, a joyous amphitheater of water spilling over terraces with rock work and shells. This was his final work for Versailles. In the Sun King's day, the royal family and the court gathered to watch dances performed on a platform island stage placed in the center of the grove. Le Nôtre was inspired, Lablaude later explains, after the old master returned from a trip to Rome, to incorporate fountains as magnificent as the Villa

d'Este and an amphitheater suggested by the Colosseum into the Salle de Bal.

When I round the corner into the Bains d'Apollon I see the dramatic change in styles from the 17th century to the 18th. Le Nôtre's ordered symmetry gives way to Romantic artist Hubert Robert's theatrical creation for Louis XVI. Where nature was once trim and tidy, here it is released. Waterfalls tumble out of shadowed caverns, flowing over mossy boulders into a pond decorated with clumps of flowers and ferns. If Le Nôtre himself were to loaf and invite his soul on the shady lawn, I can picture him shaking his curly wig in loud lament: first Mansart rips out my beloved hedges and goes overboard with the marble; now this Robert lets nature run amok as if civilized Frenchmen were meant to live in the jungle. I can imagine the grizzled gardener itching to get his hands on some shears to snip away at the Baths' confounded greenery.

Not me. It's perfect as is.

While the restoration of the main palace gardens is starting to take shape around Le Nôtre's original design, the Trianon area, including the Grand Trianon, the Petit Trianon and the queen's Hamlet, will take far longer. "Since 80 percent of the trees were knocked down there, it could take more than a century for the woods to regrow," explains chief gardener Alain Baraton.

Here, at the Trianon, as in the palace gardens, the storm yielded a few unexpected benefits. In Marie Antoinette's day, the queen could look down from her bedroom in the Petit Trianon across fields of wheat and oats to keep an eye on her mock farm and village in the Hamlet. But, according to Baraton, the 19th-century gardeners planted trees randomly and blocked this view. The storm obliged by knocking them down. "It will be the first time the garden has ever been replanted to look as it did in the time of Marie Antoinette," he says.

A decade before Marie Antoinette became queen in 1774, Louis XV had transformed the gardens around Petit Trianon into one of the most advanced botanical collections in Europe, with an elaborate hothouse sheltering 4,000 varieties of plants. Unfortunately, Marie Antoinette, not yet 19 years old when she became queen, had scant interest in botany and ordered the legendary collection of plants removed to the Jardin des Plantes in Paris and the hothouse dismantled. In its place, she constructed a heady variation on the Anglo-Chinese garden then in vogue, a romantic fantasy landscape replete with artificial grottoes, a river and a merry-go-round, the latest toy from China.

Taste in gardens, like political thought, had shifted radically since the Sun King and Le Nôtre laid out designs that illustrated man's control over nature. Robert's Bains d' Apollon were a prime example. Under the influence of Rousseau, man was now intended not to master nature but to return to it. Absolutism—whether in taming subjects or nature—was on the wane.

In the late 18th century, there was a growing scientific curiosity about American animal and plant life, piqued in part by the *Notes on Virginia* written by the new ambassador to France, Thomas Jefferson. The king's chief gardener was even dispatched to the New World to bring back native trees, some of which were flattened in the storm two centuries later. In a symbolic gesture, Baraton and Astier made a pilgrimage to the United States and brought back a Virginia tulip tree and a swamp cypress. They were planted on the first day of spring.

Despite the storm damage, the queen's Hamlet is still a charmed place, dripping picturesque melancholy and set off by impressive stands of oak, sycamore and chestnut. Rolling meadows lead down to a lotus-covered lake bordered by a miniature half-timbered village. Restored in the 1930s, the village is an operetta set waiting for players. As in Marie Antoinette's day, there is still a work-

The Parterre de Latone is dominated by a fountain exalting Diana (above). It is located at the top of the grand axis directly behind the château. The Diana fountain was a favorite of the Sun King's, and he often paused there with visitors. The lesson of turning tormentors of Diana into frogs (fountains surrounding the centerpiece) could not have escaped those who might have considered maligning the royal mistress.

"My dream is that, years after a visit, you'll whiff a long-forgotten scent of lilac and remember Trianon."

ing farm with seasonal harvests of wheat and oats. Next to the thatched roof buhrstone barn, goats, geese, roosters, rabbits and smallish gray pigs bring life to a well-tended pen. Nearby fields are studded with hay rolls as tall as a man. Gone from the houses are the sumptuous interiors filled with gold, silk and marble that made such a joke of the artfully dilapidated exteriors. When the mob arrived to end the party on October 5, 1789, and force the royal family to Paris, Marie Antoinette was sitting in her grotto, lost in reverie.

"People still speak seriously of seeing the ghost of Marie Antoinette," muses Baraton, quick to add he's never seen it. Instead of bestirring ghosts, the gardener intends to conjure up the perfumed air of the 18th-century gardens.

"My dream is to plant lilac trees so that, years after a visit, you'll be able to whiff a long-forgotten scent that summons up a memory of Trianon," he says.

"Like Proust's madeleine and the remembrance of things past?" I ask, joking.

"Exactly," he replies with a grin.

I volunteer that my own olfactory memory of Versailles would be the smell of cedar from one of the stupendous stumps posed like sculpture storm relics on the path leading up to Grand Trianon from the Grand Canal.

"You like my sculpture?" he says, perking up. "I'm delighted. I think they are perfect mementos of the immense strength of the storm. That particular tree was exactly 194 years old, planted for the marriage of Napoleon and Marie-Louise. I could have written its background on a label, but I did not. Would you like to know why?"

He continues, without waiting for a reply. "I want people to count the tree rings and guess the age. I've heard people guess 100 years, 200 years, even 400 years. Incredible! We have to leave something to the imagination. We have to keep some things a mystery, no?"

Oui.

Frequent contributor Richard Covington wrote about the Leaning Tower of Pisa in the June issue of SMITHSONIAN. *Gail Mooney captured the jump and jive of swing dancing in March 1999.*

THE JOURNEY BEGINS

Ever fancy a stroll in the footsteps of the Sun King?

EVEN NAPOLEON Bonaparte and Marie Antoinette, both former residents of Versailles, cannot outshine King Louis XIV, whose megalomania gave rise to these spectacular gardens, the park, the château and the Trianon. He likened himself to the god Apollo and became the Sun King. Just as the sun gives a regimented and unquestioned order to the day, so Louis XIV ruled 17th-century France. When he arose each morning and retired each evening, many dozens of courtiers celebrated the event with pomp and circumstance. As author Richard Covington writes, the gardens of Versailles came to symbolize the centralization of control and absolute power that the Sun King exerted over his domain.

TO VISIT VERSAILLES, only a short train or bus ride from Paris, is to experience the Sun King's extraordinary ambitions. We recommend a day trip on a Saturday or Sunday in the summer when the fountains play, and returning on an evening for fireworks and *Les Fêtes de Nuit*, a re-creation of Louis XIV's extravagant parties. The gardens are open in the summer from 7 A.M. to 9:30 P.M. daily (admission is free; the Website address is: www.chateauversailles.fr).

THE TOUR, "Discovering the Gardens and Groves," goes to areas usually off-limits to the public (no reservation is required; admission is 20 FF, or about $3; call 33-1-30-83-7780 for tour times). The château is open every day except Monday. Tours run 90 minutes and are best in the afternoon when the sunlight sets the Hall of Mirrors ablaze (admission is 46 FF, or about $6). It's worthwhile to visit the newly opened Coach Museum (weekends only), which exhibits extravagantly decorated carriages and wedding coaches.

WE'LL LEAVE the last words to Mark Twain: "It is wonderfully beautiful! You gaze, and stare, and try to understand that it is real, that it is on the earth, that it is not the Garden of Eden."

CHECK OUT OUR Journeys Website at **smithsonianmag.com/journeys** for a lot more information about Versailles and visiting there.

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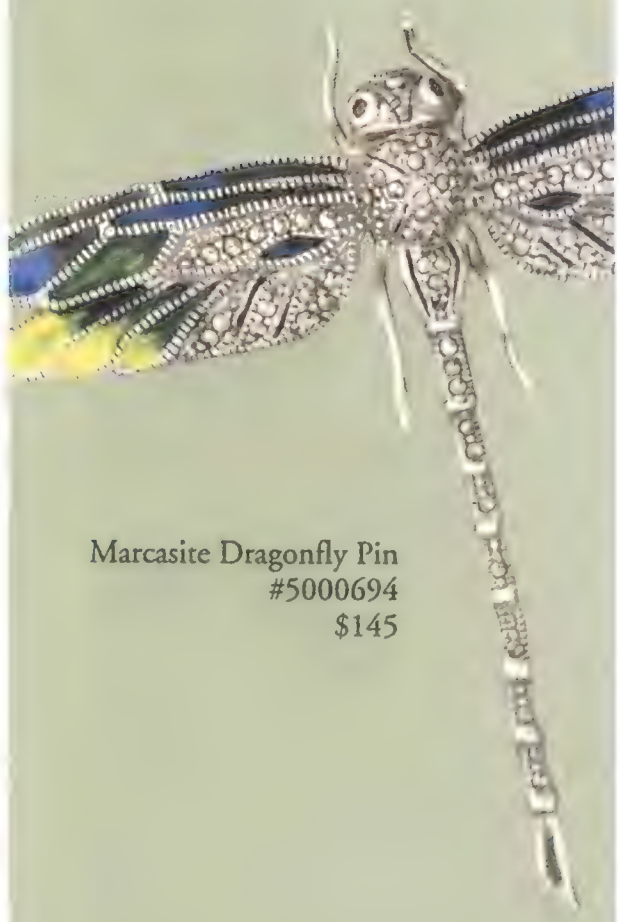

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SAMUEL PEPYS' LONDON CHRONICLES

THE CANDID DIARIST PORTRAYS THE RAVAGES OF FIRE AND PLAGUE, THE BAWDY COURT OF CHARLES II, AND HIS OWN ROMPS WITH MAIDS

IN THE YEAR 1703, AN ELDERLY GENTLEMAN NAMED Samuel Pepys (pronounced "peeps") passed away in the London suburb of Clapham. He was wealthy, and a bachelor since his wife had died more than 30 years before. Known to his numerous friends as an amiable and competent connoisseur of music and books, fond of science (but hardly skilled in it), he had once served as a naval administrator. For more than a decade, however, he had been out of office, spending his time assembling materials for a naval history he meant to write (but never did) and performing charitable works. A close acquaintance, mourning him, called him "a very worthy, Industrious & curious person."

Which might have summed up the life of Samuel Pepys, except for one fact: for nine years, from 1660 to

BY CHARLES ELLIOTT

The Great Fire of London, a "horrid malicious bloody flame," said Pepys, sent panic-stricken citizens scrambling into riverboats in 1666.

1669, right through some of the most colorful and stirring events of English history, he kept a diary that may well be the best ever written. It is certainly one of the most famous, and the most fun to read. Its publication, in effect, opened a window straight into the rowdy, dangerous, gossipy, scandal-filled heart of Restoration London.

Pepys was 26 when he started his diary, a young man on the make. Although money was tight, his prospects were brightening, and he already had what he needed most—connections. Edward Mountagu, later to be earl of Sandwich and a considerable figure in the court of Charles II, was a relative by marriage. He had hired Pepys, then just down from Cambridge and about to be married, as his London agent. Pepys' own background was far more modest. His father was a London tailor, but in spite of his family's circumstances, the youngster still managed to get an excellent education.

He had a knack for being present at great events. He was in the crowd to see one of the regicides—the men who brought about the death of Charles I—hanged, drawn and quartered ("he looking as cheerfully as any man could do in that condition"). By then, Charles II was on the throne, the Restoration era was in full swing, and Pepys was at the middle of it.

He had been, in fact, in the middle of the Restoration itself, accompanying his patron Mountagu when he brought Charles back to England to be crowned. After that, with a key job in the Navy Office, Pepys not only began to make serious money but was well placed to be aware of the doings of the court. There was plenty to be aware of. Charles, though married to a Portuguese princess, disdained any sort of conjugal fidelity, and the rest of the courtiers followed suit. From the countess of Castlemaine (an elegant beauty much admired by Pepys) to the onetime orange seller Nell Gwyn, "pretty witty Nell," the royal mistresses were numerous and beautiful.

When he sat for this portrait in 1666 during the second Anglo-Dutch War, 33-year-old Pepys, called "the right hand of the Navy," was already one of its chief administrators.

Charles himself, in the estimation of one historian, was "one of the most worthless of our monarchs, and the most beloved. . . . He believed neither in the honour of man nor the virtue of woman. . . . " Pepys delighted in collecting scurrilous stories about him. "This lechery will never leave him," Pepys remarked. This did not mean, as we shall see, that Pepys was immune to similarly lecherous behavior.

In view of its style and pretensions, the court of Charles II was notably lacking in one thing—money. Pepys reports witnessing the great hullabaloo caused by the discovery that the king had no handkerchiefs. It turns out that the linendrapers hadn't been paid for so long that they stopped the supply. Worse, the Grooms of the Bedchamber had carried away all the linen left in lieu of unpaid wages. "They will run away at the Quarter's end with what he hath had, let the King get more as he can."

Money was the abiding problem in

NATIONAL PORTRAIT GALLERY, LONDON; © THE MARY EVANS PICTURE LIBRARY, LONDON; © THE BRIDGEMAN ART LIBRARY, NEW YORK

the Navy Office too. As Clerk of the Acts, Pepys was gradually taking on a central role in the modernization and maintenance of a professional standing naval force. Until then the navy had existed mainly in times of crisis, assembled on an ad hoc basis and allowed to fall apart when the fighting was over. In the mid-17th century, such an arrangement was both dangerous and uneconomical. Britain was only as safe as it was able to control the waters around it, and its prosperity depended on supplanting the Dutch as the leading maritime power. Yet the tasks with which Pepys was involved—building and repairing ships, buying supplies, paying seamen—and all the other demands of creating a navy—cost money.

In all his years as a navy administrator, Samuel Pepys never solved the problem of naval funds. No one could have. His diary makes plain that it was only through the most dedicated efforts to control expenditure and cut down on corruption that any headway at all could be made. Such measures could be extremely painful, and they didn't always work. The eternally troublesome matter of how to pay seamen and shipyard workers tormented Pepys more than once. "A whole hundred of them fallowed us—some cursing, some swearing, and some praying to us."

To Pepys personally, however, money ceased to be a difficulty early in his career. It does not do to inquire too closely about where his money came from. As Lord Sandwich had once told him, "it was not the salary of any place that did make a man rich, but the opportunities of getting money while he is in the place." Though Pepys was relatively scrupulous about not cheating his master the king, he also felt that a bribe from a timber merchant didn't necessarily mean crooked masts for the ships. And compared with most bureaucrats of the time, he was an unusually moral and upright character.

The same could not necessarily be said for his personal conduct. In fact, Pepys' sexual adventures outside his household (and sometimes inside as well, with attractive young servant girls) were enough to shock his first editors and readers of the diary. Only mutilated and expurgated versions were published for more than 150 years after its first transcription in the early 19th century. (The diary, written in shorthand with occasional names and words spelled out, filled nine volumes when the first complete edition was published in 1970.) Pepys' wonderful frankness about his own urges, and the activities those urges gave rise to, is one of the elements that make the book so readable.

Elizabeth St. Michel was only 15 when Pepys married her, but judging from portraits, she was handsome, even voluptuous. Pepys was often savagely critical of her, however, complaining about her dress sense, her choice and treatment of servants, her taste in books (she preferred popular romances), her inability to carry on an intellectual conversation. Worse, she had a nasty temper, and wasn't averse to showing it. Pepys had a temper, too, unfortunately, and more than once was driven to twist her nose or even to hit her, which by the standards of the time he was thought to have a perfect right to do. "The poor wretch did cry out and was in great pain," he wrote, "but yet her spirit was such as to endeavor to bite and scratch me."

Even so, their relationship, according to Pepys, could be a loving one. The diary frequently mentions long mornings spent lying in bed talking, "merry and pleasant," and the quarrels rarely lasted for more than a day. Pepys' willingness to accommodate her with a new jewel or a lady companion or a fine carriage was not entirely a matter of showing off his own possessions—though this surely played a part. As time went on, however, and his inclination to search for

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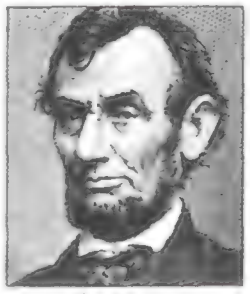

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satisfaction elsewhere came more and more to the fore, keeping Elizabeth quiet took on a certain urgency.

Because the fact is that Samuel Pepys was a bit of a tomcat. ("A strange slavery that I stand in to beauty, that I value nothing near it," he once remarked.) He could scarcely look at a pretty woman, especially one of a lower class, without contemplating how to seduce her. He had a few regulars—Betty Martin and her sister Doll, merchants with a stall in Westminster Hall; Mrs. Bagwell, the pretty wife of a ship's carpenter; a couple of actresses. More often, however, he simply made the moves on barmaids or servant girls, "dallying" with them or "tousing" them in hopes of getting more. Sometimes he failed to get even that far. During church services one Sunday in August 1667, he "stood by a pretty modest maid, whom I did labour to take by the hand and the body; but she would not, but got further and further from me, and at last I could perceive her to take pins out of her pocket to prick me if I should touch her again; which seeing, I did forbear. . . ."

Domestic affairs in the Pepys household finally reached a crisis point when Deb Willett, a charming young lady, scarcely more than a girl, was hired to be Elizabeth's personal maid. From the beginning Pepys vaguely anticipated trouble, worrying "lest I may be found too much minding her, to the discontent of my wife." Predictably, he was soon besotted. Catching the pair in a less than chaste embrace one evening while Deb was as usual combing Pepys' hair, Elizabeth exploded in a paroxysm of rage that went on recurring for weeks and included, among other things, a threatened attack on Pepys with a pair of red-hot fire tongs. Pepys was forced to agree to Deb's dismissal, though in his self-centered way he thought mostly of his own loss. "I cannot forget the girl, and vexed I know not where to look for her."

The candor with which Pepys tells of Deb and his other amours is irresistible; he never for a moment tries to prevaricate or evade, even when the account casts him in an extremely dubious light. He is similarly honest about his drinking, about his vanity, about his greediness for money. Yet his energy, optimism and endless curiosity about the world and everything in it are overwhelming. Moreover, he is a terrific reporter.

The years 1665 and 1666, for example, were a time of war, plague and fire. From his vantage point at the Navy Office, Pepys was in a position not only to follow closely the events of the struggle with the Dutch over control of the Narrow Seas but also to play an active role in the victories, the defeats, and the embarrassing, frightening final act, when in 1667 the enemy sailed up the Thames estuary within striking distance of London.

The Dutch Wars took place almost entirely at sea. Pepys' problem, as usual, was to get a sufficient number of ships manned and equipped, and to make some sense out of the command structure. Traditionally, wartime command at sea went to aristo-

Pepys professed adoration for his wife, Elizabeth, but his failure to resist other beauties provoked her wrath.

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The Dutch handed Britain a humiliating defeat in 1667 when they sailed up the Medway River and set fire to some of the most powerful ships in the English fleet.

crats, many of whom knew little about naval matters compared with the sailors (known as tarpaulins) forced to serve under them. In 1665 the Lord High Admiral was the duke of York, the king's brother. He won one battle, but because of a command error on the part of another gentleman, most of the Dutch ships escaped. Pepys, not knowing of the aftermath, exulted: "A great victory, never known in the world."

For Pepys himself, the events of 1667 were more unsettling yet. In June, word came that a Dutch fleet was approaching the Thames estuary and threatening the English naval base up the Medway River at Chatham. His first thought was for his hoard of gold, which he kept in a chest in his house. Packing up as much as he could, he sent it with his wife and his father to the country, telling them to bury it in the garden. Then he put £300 in a money belt around his waist. In the end, the Dutch, after seizing one first-rate ship and burning others, returned to Holland, but the Navy Commissioner at Chatham was made the scapegoat for the disaster and arrested. This, for Pepys, was awfully close to home. Still, ever on the lookout for gossip, he reports that "the night the Duch burned our ships, the King did sup with my Lady Castlemayne . . . and there were all mad in hunting of a poor moth."

Running through Pepys' account of the sea battles of 1665 are many entries dealing with a more deadly phenomenon. One day in June he noticed, "much against my Will," two or three houses in Drury Lane with red crosses and "Lord have mercy upon us" marked on the doors. It was the plague, the mysterious disease that had so often before devastated London and other urban centers. The plague was lethal; historians have calculated that a victim had a 60 to 85 percent chance of dying, usually within five days. In the steaming heat that summer, the death rate rose inexorably, finally reaching eight or ten thousand a week, Pepys estimated. Those who could flee the city did; Pepys sent his wife to Woolwich and moved the Navy Office to Greenwich, but commuted to London to contend with the administrative chaos of the Dutch War. A letter Pepys wrote contains vignettes of horror: "The nights (though much lengthened) are grown too short to conceal the burials of those that died the day before . . . my brewer's house shut up, and my baker with his whole family dead of the plague," his own doctor, "who undertook to secure me against any infection," dead too.

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Probably the most magnificent set piece in the entire diary is Pepys' description of the Great Fire of London. It began on September 2, 1666, in a bakery only a quarter of a mile from his house and office in Seething Lane. It came at the end of a long drought and was fanned by a strong wind. "With my heart full of trouble," Pepys ventured out, and found widespread panic—people desperately trying to save their goods by loading them into boats on the river, or simply flinging them into the water. Even "the very stones of churches" seemed to be burning.

During the next four days, more than 400 acres of London were reduced to ashes. Pepys' account is filled with the kind of details only a born reporter would notice—the pigeons "loath to leave their houses . . . till they were some of them burned, their wings, and fell down"; the Lord Mayor, crying "like a fainting woman, 'Lord, what can I do?'"; poor people smashing open barrels of expensive sugar, putting handfuls into beer and drinking it. As the fire came closer and closer to the Navy Office, Pepys and a neighbor dug pits in the garden to bury documents, along with his wine and "parmazan cheese," eventually fleeing with his wife and his gold to Woolwich. He never expected to see his house again. But firebreaks made by blowing up nearby houses with gunpowder saved it. (It was to burn to the ground seven years later anyway.)

At the end of May 1669, Samuel Pepys gave up the diary. He was, he feared, going blind. He was probably only suffering from astigmatism and uncorrected long sight. In any case, he would not continue to record the events of his life with such unembarrassed openness and pleasure, and the world is the poorer for his decision.

Yet it would be wrong to conclude that Pepys was no more than his diary. We know that he subsequently did as much as any man, and more than most, to create what would become the world's greatest navy. His struggles against corruption and mismanagement went on through the early 1670s, along with the agonized search for funds to build the ships and pay the seamen. Some of the worst crimes had been brought at least partly under control—open theft of naval goods such as rigging and timber, large-scale graft, cheating by contractors with monopolies to supply food and drink. But financing was never adequate. Personal crises continued too: in the fall of 1669, after a trip abroad, Elizabeth came down with a sudden fever and died. Without his frank diary entries, we never learn what her death meant to him.

As he moved up in government service, he attracted wealth—and enemies. Caught between the real demands of a navy expected to do its duty, the suspicions of an unfriendly Parliament, and the culpable ignorance of a king to whom he had sworn loyalty, Pepys was bound to have a tough time of it.

He looked for support to James, duke of York, the king's brother, and became a loyal follower, even though the duke was an avowed Catholic. The duke was, after all, a naval man, and until 1673, Lord High Admiral. In that year, ominously, Parliament passed the Test Act, banning Catholics from holding public office, and James was forced out. For a half-dozen years, Pepys worked creatively and effectively. He was made Secretary to the reorganized Admiralty—one historian remarks that the "plain fact was that there was no doing anything in the navy without him." He also became a member of Parliament. But clouds of religious intolerance were gathering—encouraged by anti-Catholic propaganda, suspicions about the king's own religious position (he was married to a Catholic), and concern that the duke of York was next in line to the throne.

For Pepys, the situation was pre-

An engraving depicts a heavily wrapped Pepys stealthily making his way through London streets during the Great Plague.

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carious. Somehow, evidence against Pepys and his friend, the naval architect Anthony Deane, was scraped together, including preposterous testimony by his ex-butler (fired for sleeping with Pepys' housekeeper) that his house was filled with crucifixes and Romish images. Accused of treason by a Parliamentary committee on charges of having sold the French secret charts of the English coast in preparation for invasion, Pepys and Deane were packed off to the Tower. It was six weeks before they were released on a huge £30,000 bail.

Pepys methodically set about collecting the evidence needed to clear himself. He assembled so convincing and impressive a dossier that he was half-disappointed in the end not to be able to use it. (Under pressure from various quarters, the prosecution finally gave up the case.)

But he was now a man without a job, forced onto the sidelines while court and Parliament struggled for supremacy. England was on the brink of civil war, until the king managed to get the upper hand. In 1684, recognized as an indispensable administrator who was loyal to the Stuarts, Pepys again became Secretary of the Affairs of the Admiralty, answering to no one but the king and the returned duke of York. It was a position of unprecedented power.

Given his keen understanding of politics, there is little doubt that Pepys knew, even as he was refashioning England's sea power, that the ground under his feet was extremely unsteady. In 1685 King Charles died and his brother succeeded as James II. At once all of the old religious animosities surged forth, exacerbated by James' ham-handed policies. By 1688, when the Protestant William of Orange made a bid for the throne, the country was happy to see the Stuarts go. For Samuel Pepys, this really did mean the end of his career.

It has been said that we know Pepys better than any other man of his time, which is probably true. Yet much of what we know is what he wrote in the diary. The contrast is so vast as to be almost unbridgeable between the living, breathing, utterly human young thruster walking the pages of the diary and the mature bureaucrat, the heavyset man in the full-bottomed wig who ran the Royal Navy and retired into bookish old age with his library and music and famous friends and few bad habits. On the other hand, it is possible that no contrast existed, that a diary covering any other nine years of Pepys' life might have been charged with the same energy and color, that he actually ended as he began—talented, contradictory, principled, petty in some ways and great in others, and endlessly fascinating.

London-based author Charles Elliott says he has read Pepys' diary several times.

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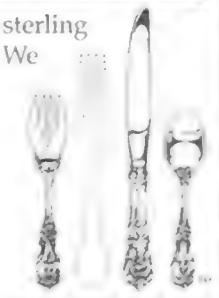

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THE LAST PAGE

Drive In, Conk Out

BY LARRY WALLBERG

IN THE AGE OF DVDS, I DOUBT whether it's a thrill anymore for kids to be able to watch a movie while they're in their pajamas. But back in the 1950s, my sister and I considered it a treat to have Mom and Dad throw coats over our pj's and take us to the drive-in. I loved the idea of getting to stay up late, but Dad always deflated my expectations. "Listen," he'd say, "it won't be such a tragedy if you conk out. I'll tell you all about the movie tomorrow."

We piled into our green Studebaker, looking like we were going on an expedition. Mom carried a giant bag of chips, which would be gone by the time we were five blocks from our apartment, and a cooler with watery orangeade that nobody ever drank. Risa was allowed to bring her wetting baby doll and her cap gun, although Mom had a strict rule that there was no peeing or shooting in the car. I schlepped along a pile of five or six comics, even though I knew it would be too dark to read. My taste ran to second-string heroes: J'onn J'onzz, Manhunter from Mars; Turok, Son of Stone; Tomahawk (a Daniel Boone rip-off); and, hidden among the macho stuff, Little Lulu, which was really my favorite, even though I felt compelled to say, "Hey, how did this get in here?"

When we arrived at the drive-in, Dad would begin looking for the spot farthest from the concession house. "Do me something," he'd say. "You don't need French fries and chocolate-covered raisins to watch a good story. Anyway, you kids'll be asleep before you're hungry."

Next to the concessions, though, there was a small playground where dozens of children ran wild in the vanishing light until the movie started. Mom's idea was that Risa and I could get ourselves exhausted on the swings. "Don't park a mile away," she'd command. "The kids need to play."

"I'll move my seat up," Dad would say. "Didn't they play already today?"

I had no intention of romping with strangers while I was sporting my fireman shorties. But I voted with Mom because I knew that eventually she'd send me, over Dad's protestations, to buy Necco wafers and bonbons. If the car was too far away, I was afraid I'd get lost.

Risa and Mom seesawed while I nervously stood in line to get refreshments, picturing myself hopelessly wandering the parking lot forever in my slippers. I'd crane my neck to keep my eye on the car. Here's what I'd see: Dad fiddling with the sound contraption. You were supposed to pick the speaker up from its holder, lean it by its metal ledge onto the side of the window, and roll the window up to hold it in place. But Dad could never get it to work. He'd put the speaker on the outside instead of the inside. Or he'd forget to roll the window up, so that the speaker crashed to the ground as soon as he brushed against it. Or he'd try to stretch it into the car and balance it on the dashboard. Finally, he'd just hold it until Mom returned. "You're the mechanical one," he'd say. "Fix this stupid thing."

Right before the show, Risa and I would be packed in with pillows and blankets until we looked like a pair of reluctant mummies. "I don't wanna hear a peep out of anybody once my story starts," Dad would warn us. My parents' idea was that we kids would stick around for the introductory cartoon and maybe the first 15 minutes of *No Time for Sergeants* or *The Spirit of St. Louis*, and then fall into a stupor. But it never worked that way.

The first one to go was always Dad. He'd be snoring before the coming attractions were over. "Lend me one of your pillows for your father," Mom would say to me.

Three or four hours later, I'd finish off the last of the Necco wafers and rouse everybody. "Hey, it's over! Time to go home."

"What the heck are you doing up?" Dad would ask, yawning. "Was the movie any good?"

"I'll tell you all about it tomorrow," I'd say.

DAN VASCONCELLOS

Your guidance counselor said

you would never amount to anything.

Your guidance counselor drives a minivan.

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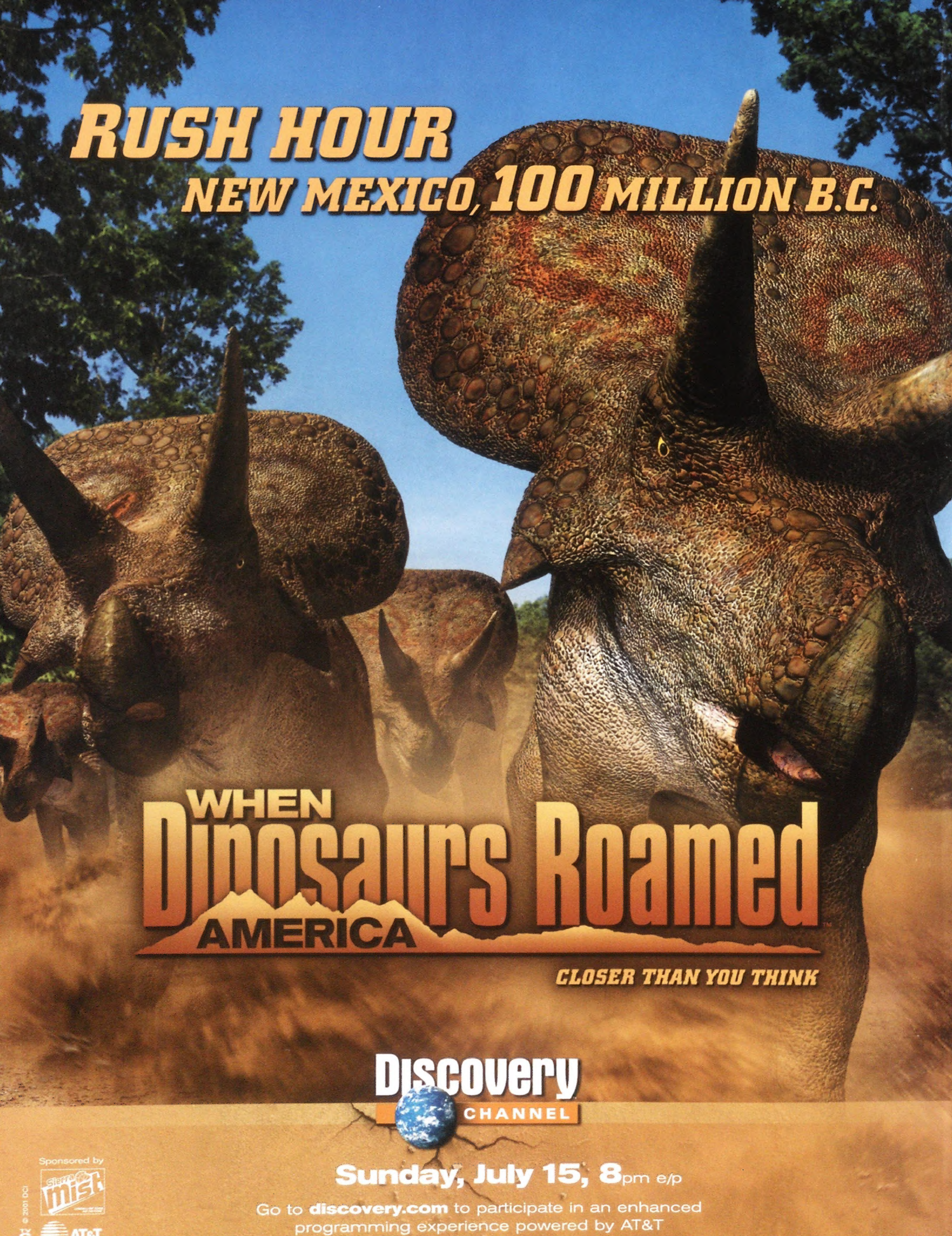
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